Abstracts Booklet

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KEY NOTE SPEAKER

THE ROLE OF CHEMISTRY, BIOLOGY & PROCESS ENGINEERING IN THE FIGHT AGAINST MICROCONTAMINANTS PRESENT IN THE URBAN WATER CYCLE

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The pollution of urban water cycle caused by microcontaminants has been attracting the attention of the international scientific community during the last decades. Microcontaminants are released from products that are used daily, such as pharmaceuticals and personal care ones, food additives, pesticides, and industrial chemicals, at very low concentrations; ranging between ng/L to μg/L. Whatever the source of these microcontaminants, they can reach various environmental compartments as they are persistent and non-biodegradable. Their occurrence has been reported worldwide in wastewater, surface water, groundwater, soil and sediments, and even drinking water. Urban wastewater treatment plants (UWTPs) are a major point source of these microcontaminants in the environment, since the conventional treatment technologies applied in UWTPs were never designed to completely eliminate such microcontaminants. This means that these are detected in treated wastewater and can consequently are able to reach the environment through wastewater discharges and/or reuse applications.

The prevalence and continuous input of these microcontaminants into the aquatic environment, has been shown to potentially induce endocrine disrupting activity and other adverse biological effects (e.g. toxicity, estrogenicity, reproductive and developmental abnormalities) on various organisms. Also, their accumulation in soil and their potential uptake by crops and plants irrigated with treated wastewater have been recently documented.

This is a fascinating multi-disciplinary research field where *Chemistry* and *Biology*, *Technology* and *Engineering* and also Mathematics (through kinetic aspects and statistical analysis of results) meet, in order to develop water and wastewater treatment technologies and also other chemical and bio-analytical systems to assess the presence and effects of such contaminants, with the overall aim to face the current relevant challenges.

STUDENT PRESENTATIONS IN MATHEMATICS

MP1. FINITE ABOUT INFINITY

Dunja Galinec, Martin Unger
Gimnazija “Fran Galovic” Koprivnica, Croatia

Infinity is a concept describing something without any bounds or larger than any natural number. It is not a real number, but simply an idea and it can’t be measured. Modern mathematics uses the idea of infinity in the solution of many practical and theoretical problems. The idea is also used in physics and other fields of science. Ancient Indians and Greeks did not define infinity as well as modern mathematics. They approached it as a philosophical concept. The first person to introduce us to infinity was Georg Cantor. There are various examples of infinity like infinite numbers, hotel infinity, infinite sets and interesting paradoxes. There are also scientists that deny the idea of infinity. Infinity can be used like it is a real number beacuse it has a symbol, but it does not behave like a real number because it’s endless. There are many discussions about this topic and one of them is the idea of different sizes of infinty and it goes beyond the simple concept of infinity. Most things we know have an end, but infinity does not- that's what makes it so interesting.

MP2. FRACTALS AND NATURE

Leonarda Jurendic
Gimnazija “Fran Galovic” Koprivnica, Croatia

The word fractal was coined by scientist Benoit Mandelbrot. He realized that the nature is far more complex than to be described using terms such as straight line, cube, cylinder, circle etc. In this sense he proposed the term fractal for each irregular shaped natural object, and fractal geometry, as the discipline which explores fractals. According to Mandelbrot, real natural objects such as coastlines, clouds, trees, stones with pores and many other objects could be described using fractal geometry. Therefore, using fractal geometry and fractals enables scientists to describe each natural object without any approximation with regular shaped objects. One of the best known mathematical fractal models which can describe how natural things grow is the Mandelbrot set. The coast and area of Cyprus could be described by fractal geometry too.

MP3. HOW HAS MATH SHAPED ASTRONOMY?

Marta Kunstic
Gimnazija “Fran Galovic” Koprivnica, Croatia

Astronomy has been around ever since people started showing interest in science. The earliest humans looked up at the sky and saw constellations with no light pollution. The first mathematicians were almost always also astronomers, including Ptolemy, Aristotle, Eratosthenes and many more. Mathematics is a vital part of Astronomy and has been since the dawn of science. Eratosthenes calculated the circumference of the Earth by comparing altitudes of the mid-day sun at two different places, the pyramids were built to resemble constellations, Newton calculated the gravitational constant… Today, Mathematics is even more important. It has already sent us to the Moon and is about to send us to Mars. Astrophysicists calculate thousands of different things every single day. From the most basic parts of Astronomy, like counting days, to some parts that are only taught to university students, Math and Astronomy have always been connected. I want to explore the harmony of these two sciences and show that Mathematics doesn't only shape the world around us, it shapes worlds and galaxies we haven't discovered yet.

MP4. MATHEMATICS IN MOVIES

Jakov Dolenec
Gimnazija “Fran Galovic” Koprivnica, Croatia

Today entertainment is an important part of our lives. Some forms of entertainment are sports, music, Internet, video games, movies, etc. As I come across movies and mathematics every day I decided to make a presentation about mathematics in movies. When people hear about math in movies they only think about numbers, so the movie budget, movie quality, the price of the movie ticket in cinemas, but math in movies is not only numbers. Different forms of movies use different parts of mathematics. For examle animated movies use a lot of geometry for their production, whereas live action movies do not use that much geometry but they use different calculations for calculating depth of field. I will show you how important Pascal's triangle is in animated movies for making curves. This presentation shows that movies would not exist without mathematics.

MP5. WOMEN IN MATHEMATICS

Mirta Strbad, Irina Vuckovic
Gimnazija “Fran Galovic” Koprivnica, Croatia

Women have been neglected in the world of science for many years and it was considered inappropriate for them to take part in what was believed to be only intended for men. Nowadays not many women are known for being influential mathematicians and their work isn’t valued enough, even though many of them have made the same if not greater discoveries then men. For that reason we have decided to tell you the stories of women in mathematics. Our goal is to introduce the impact that women had made in mathematics to as many people as possible and have them appreciate women even more. Worth mentioning is the fact that many women’s ideas and proofs led to great improvements in future by proving some theorems. Starting from the ancient Greek time we will mention the first women to make a known impact in mathematics, such as Teano and Hypatia, and ending in modern times from 18th through 20th century to talk about mathematicians such as Maria Gaetana Agnesi, Sophie Germain, Louise Schmir Hay and many others.

MP6. MATHEMATIC IN ART

Ella Vrabelj
Osnovna skola “Braca Radic”, Croatia

Mathematics has important role in all of our lives. Sometimes it is visible directly and sometimes it is an indirect connection. At the first sight we don’t see too big connection between math and the painting, except when someone wants to buy a certain picture. But there is indirect connection as well.

Painting is the art of shaping the surface with different pigments. Artist, based on his knowledge and math skill, has to know how to measure surfaces to be able to choose right size of the canvas for his masterpiece. After the canvas has been chosen artist has to determine highest and lowest spot of his painting. In order to do that, he has to calculate the centre of his picture. Many artists are using geometric figures and bodies that enrich the image and make it look beautiful.

At the start of the colouring process the artist has to use the proportion technique to get to the wanted density and pigment of the colour (e.g. 2 drops of white / 5 drops of violet colour).

As you can see painting is not possible without some skills we learned through math science. Math is making process of developing beautiful pictures easier and better.

MP7. MATHEMATICS AND THEATRE

Ema Vinkovic, Petra Habdija
Osnovna skola “Braca Radic”, Croatia

Mathematics is everywhere around us and we're here to recognize it. It does not always have to be serious, difficult to solve, or strictly professional. Mathematics can be social and full of fun. Mathematics is therefore in the theatre.

The theatre itself is in fact mathematics, and the real examples are: ticket prices, seating plan in the auditorium, fabric for the costumes, stage appearance. Let’s take ticket price as an example. A discount for tickets should always be foreseen, for children or for group visits. Of course, one should not forget that the ticket price must not be too high; otherwise the theatre might not be adequately visited. On the other hand, the price should cover wages of the actors and employees, so the price should be fair. Likewise, the amount of fabric for making of the costumes should be calculated properly so that the right amount of materials can be purchased. Besides the hairstyle, makeup, accessories and costumes it is necessary to calculate the consumption of electricity that is consumed by a variety of reflectors.

According to the aforementioned, we can conclude that mathematics is present at every step of our lives, even when we visit the theatre to see an interesting play.

MP8. MATHS AND BICYCLING

Fran Filipovic
Osnovna skola “Braca Radic”, Croatia

Maths is everywhere around us. Many people are crazy for bicycling, and so am I. Therefore, I'm going to talk about maths and bicycling. At the first glance we can't see maths in bicycling, but I will show you there is actually more maths than you think. There are many questions we ask ourselves: How much money do we save if we are riding a bike? How many kilometres do we cross in given time at a given speed? Is the weight of the bike important?

We all know the weight of the bike is very important, because heavier bike is harder to pedal and vice versa, but cost comes into play. For example if you weigh 72kg, and your bike weighs 7.2kg your bike is 10 percent of your mass. Saving money to buy a new frame 400g lighter saves you about half a percent of your total mass.

My family and I ride bikes a lot. I like riding a bike because it’s healthy.

Recently I was racing a humanitarian race and we travelled about 40 km in only 2 hours, and from that we can calculate my speed as well as other interesting things.

By riding a bike we do not only save our money, but protect the environment, recreate ourselves and maintain our health.

To conclude, I will show you how maths and physics have connections with cycling and how they affect this story.

MP9. MATHEMATICS IN PROGRAMMING

Fran Vlahovic
Osnovna skola “Braca Radic”, Croatia

Maths and programming are very close connected. I have already been introduced to many different programming tools and realized their close connection with maths because of their logical way of thinking. I used many different programs like Python, Arduino, MBlock and Robo Pro. I think that people who don’t understand and don’t like maths will have many difficulties with programming.

When we start with programming, in most cases, we first try solving simple tasks like adding up two numbers. Solutions to problems in programming are mostly numbers and not words. Using numbers and lines is needed in algorithms.

I have chosen this topic because maths and programming both attract my curiosity strongly. With deep math knowledge and mathematical way of thinking, my chances to become good programmer are definitely better.

MP10. COOKING WITH A LITTLE HELP OF MATHS

Josip Mikulic
Osnovna skola “Braca Radic”, Croatia

There is no better feeling in the whole wide world than eating delicious food. Although we all enjoy eating, some people don't prepare their own meals. Either they don't have the time, don't know how to, or they just prefer not to cook. Now I'm no Gordon Ramsay, but I can make some delicious meals. In this presentation, I will be sharing my grandmother’s recipe for the most delicious Strukli.

Strukli is a traditional meal in Croatia. It originates from the northern part of Croatia, Zagorje. It is a pastry that is pulled very thin and filled with cottage cheese. It is then rolled in a shape of a circle or a rectangle. It is often served with cream cheese on top. I will explain where the mathematical part of the recipe comes in, and how math is involved in every cooking process. For example, there are units of measurement which can all be converted to several forms. There are also fractions which can find their way in the recipe; I will be explaining them, too.

Cooking and Maths often go together, and when they cooperate, they can make the most delicious duo. If you know how to apply Maths in cooking, you can prepare a meal, no matter how complex it is. So there is my conclusion: with Maths, you can do anything you want.

MP11. MATHEMATICS AND GEOMETRICAL PATTERNS

Lara Vukovic, Tara Sambar
Osnovna skola “Braca Radic”, Croatia

We still remember the first days of school when we sat in the first rows with braids in our hair and when we started to learn about geometry. We fell in love with it immediately. Of course, we would always forget something on the days we had geometry; divider, ruler or set-square.

Those geometrical shapes such as circle are now on our clothes, furniture, and all around us. Squares and rectangles are also all around us. Fashion designs would be boring without geometry and that is why we use it in many different styles.

We would be thrilled to tell you more about it!

MP12. MATHEMATICS AND CROATIAN FOOTBALL TEAM

Lorena Siroki
Osnovna skola “Braca Radic”, Croatia

The Wold Football Cup was not so long ago, and as you might know Croatian Football Team placed second. I want to tell you a story about our team and mathematics. Most kids in my school love football, but hate mathematics. And because of what our team achieved, their love for football only grew. Everybody wants to be Luka Modrić, Ivan Rakitić or Mario Mandžukić. That is what drove me to try and connect mathematics and football. I will talk about the role of mathematics in the game of football, about statistics and numbers related to our team's success at the World Cup in Russia, but about the best game in the world – football, as well.

MP13. APPLICATION OF MATHEMATICS IN ANATOMY OF HUMAN BODY

Lovro Priselec, Ivan Sinjeri
Osnovna skola “Braca Radic”, Croatia

Mathematics is applicable in many real life situations. Even Ancient Greeks used mathematics in multiple areas: sport, engineering, agriculture, wars and medicine. If they wanted to practice medicine, they needed to know human anatomy.

If we take a look at the draft of a human body, we can notice it's symmetric and consists of geometric shapes. Body parts are shaped according to the function they have. On human body we can also see a lot of fun facts that are related with mathematics. One example is golden ratio that can be applied on many parts of human body. Golden ratio is considered to have a golden proportion.

We are going to show you beauty of human body by using mathematics - from the number of bones in our hands to the DNA molecule and its structure. Mathematics makes our lives easier and helps us improve medicine, engineering, technology and lots of other things we couldn't live without.

MP14. MATHEMATICS IN GOLA

Marija Svegovic
Osnovna skola “Braca Radic”, Croatia

Throughout our life we often come across mathematics that we learn in school. My intention is to introduce you to mathematics in my village. For example, my village wasn't habited by accident. It was planned. In order to build it, authorities at the time had to send their military engineers to plan the village and its streets and parks. Hundreds of other villages were habituated by accident and next to curvy roads. But with our village it was different. A military engineer drew lines from east to west and from north to south and came up with a cross. In the middle of the cross, he made a cube. When you try to draw this on paper, you get four small cubicles, which are actually four beautiful parks. The village was built and habituated. I would like to show you how important mathematics was in my village with examples such as this.
I will show you my village in past and present. I will introduce you to the application of mathematics in measuring land, agriculture and art.

MP15. APPLICATIONS OF MATHEMATICS TO ECONOMICS

Matija Simek
Osnovna skola “Braca Radic”, Croatia

Both mathematics and economics are all around us. It is the approach to economic analysis which serves to describe and analyse a large number of economic phenomena.
Mathematics in economics helps us to, for example, form the price to make the largest possible income, organise production with the lowest costs, achieve the highest profit, reduce costs and increase revenue, reduce shipping costs, decide whether a loan is favourable or not, whether bank savings are worthwhile...
Every year, companies plan, analyse and calculate operating costs (total, fixed and variable costs), their income and profit. The goal is to achieve high profits. Profit is the difference between total income and total costs.
The stock market situation is published in newspapers and on TV every day. Newspapers often announce price increases: „Petrol prices will increase by 10 percent starting Tuesday." Many families have loans in banks which offer them the lowest interest rates.
Mathematics helps us to optimally manage finances in various areas of life.

MP16. MATHS, SCIENCE AND REAL LIFE

Nera Tomrlin
Osnovna skola “Braca Radic”, Croatia

Have you ever played a sport? I'm sure you have. Have you ever played an instrument? Have you ever cooked a meal? Ok, maybe not, but you probably made yourself a sandwich or something like that, didn't you? Have you ever calculated how much will you sleep if you go to sleep in an hour, or if you go to sleep right now? Well, it is all maths.

If you want to understand life and its beginnings you cannot avoid maths. We know that universe was created about 14 billion years ago and that it all started with the Big Bang.

We know that the material world is made of different chemical elements and that they are all made of different subatomic particles. Earth orbits the Sun in 365.25 days, the Moon orbits Earth in 30 days, etc.

Math is also closely connected to technology, for which we can thank Nikola Tesla. Without him our lives would be completely different and nobody can know if we would be where we are right now. Physics is obviously also based on math, as well as economics, sociology and all other sciences - including philosophical disciplines.

It is irrelevant if we like mathematics or not, we just can't avoid it. It's everywhere we go. My presentation will demonstrate the importance and the connection of maths with science and life in general!

MP17. LEARNING MATHEMATICS THROUGH GAMES

Niko Sertic
Osnovna skola “Braca Radic”, Croatia

Mathematics is one of the most important subjects during the school education. And there isn't an aspect of life in which mathematics isn't present, so we ask questions: How to even learn mathematics and why? How to make it interesting?

Children learn mathematics in different ways but it is not enough to learn it just to learn it, it's required to understand the point of the subject that is being learned. Not all themes in mathematics are equally interesting and that is why learning should be made more fun. One of the suggestions on how to make mathematics interesting is making it a game. It is commonly known to all of us and provides us a feeling of satisfaction and encourages the imagination and creativity.

And that is why I decided to show you, with a couple of examples, how to learn and solve mathematical tasks through some sort of games and at the same time make it more enjoyable and understandable.

MP18. MATHEMATICS IN SPORTS

Nikola Kusek
Osnovna skola “Braca Radic”, Croatia

Sport is very important part of our lives - it is good for health, developing motor skills and developing competitive character. I attend gym classes at school and I play football for Slaven Belupo, Koprivnica’s football club. We train a lot and often have matches with other clubs. I enjoy it and look forward to all of them. Apart from football, I also find other sports interesting and I like to watch them on TV. I always cheer for our national teams and athletes.

Besides sports I like math. Mathematics is everywhere around us and thus in sports. I'm sure many people are not aware of the fact that math is a big part of every sport so I will try explain it in my presentation. Math is important for measuring results, keeping records, creating statistics, etc.

Every sport has its own specifics. There are team sports and individual sports. Also, there are indoor sports and outdoor sports. Some people do sport professionally, some recreationally, but competitive spirit is always present. The main goal of a sport is to have fun, but the feeling of winning is something everyone enjoys.

Today, professional sports can be very profitable. Athletes earn a lot of money doing sports so in order to be more successful they make their own coaching teams. In their process of trying to become the best version of themselves, they use math.

How much mathematics actually affects some sports disciplines, their development and the change of rules throughout history I will show in interesting examples of the sports we all know.

MP19. MATHEMATICS AND GEOMETRY IN ARCHITECTURE

Patrik Fiser
Osnovna skola “Braca Radic”, Croatia

Mathematics is, as we know, present everywhere around us. When we look around we can see different buildings. We can recognize different geometric shapes in them. All these shapes have a purpose in the building.

Geometry is the language of the architecture. Architects use mathematical legitimacy when designing structures from inside and outside. When we take a look at the past, we can see that the ancient people used mathematics and geometry to construct different structures. Those buildings were simpler because they did not have the materials and technology we have today, but they aren't any less interesting. Let's just remember the Egyptian pyramids for which we do not know exactly how they were built, even today. The first forms were very simple, for example, balls, cubes, pyramids, quads and rollers.

I will try to explain to you, in the presentation, how mathematical and geometric forms were used in the example of the "Old Town" fort in my hometown Đurđevac, which was built in the 15th century.

MP20. FISHING MATH

Iva Betlehem
Osnovna Skola Fran Koncelak Drnje, Croatia

Fishing isn’t just catching fish. Fishing is also a sport. At first sight it doesn't seem like it includes math. But when you look deeper into fishing, math just starts showing. The easiest way to understand this fact is to take a look at a fishing competition. Why? Because everything has to be perfectly, precisely made and most importantly, balanced. Some examples of math in fishing are: ratio of ingredients in fish food, equality of lead and float's weight, making systems for different types of water and different species of fish. Luck has a big role in fishing competitions because first of all you need to draw out a number of the position from where you are going to fish. This luck is connected with possibilities. At the end of the competition judges weight all the fish you catch and they give you points. One important thing which I didn't mention is that all the fish you catch, you put back into the water from where they came. That way everything is balanced. If you are lucky enough you can get a medal. I think that fishing is a sport with the largest number of medals. The competitive kind of fishing isn't the only one. You can go fishing just to catch fish and to be in nature, but you need to respect some fishing laws. And now nobody can tell that you to forget about math when you are fishing.

MP21. WORLD CUP IN RUSSIA 2018 AND THE BIG CROATIAN FOOTBALL TEAM ACHIEVEMENT

Matej Matijasic
Osnovna Skola Fran Koncelak Drnje, Croatia

As you know, the World Cup in Russia was held this year. Football is the most popular sport in the world! We Croats can be particularly proud of our football team, who played great games and reached the excellent 2nd place for our little country. With that achievement, they made our whole nation proud and happy. Modern football is unimaginable without quality players but also high quality preparation for matches. In this presentation I will explain the connection between math and football and how it is necessary for the expert team to analyse a large number of data before and after each game, such as the number of kilometres run, the number of hits per goal, the number of correct passes, etc., both for the whole team and for individual players. It is also of great importance to prepare a suggestion of quality training for each player after every game. Also, regarding nutrition, it is especially important to count the calories needed by players for exercise and competition. In my presentation, I will explain the statistics of the best player of the World Cup Luka Modric and I'll compare him with other players.

MP22. MATH THROUGH GEOGRAPHY

Hana Siroki
Osnovna Skola Fran Koncelak Drnje, Croatia

Croatia is a small country, with a population of only 4.3 million people. It occupies a territory of 86.661 square metres, 5.790 of which belong to its coast and islands. Natural wonders and untouched nature are some of its attributes. Our Adriatic sea, with its 1185 islands and islets, is visited by 17.5 million tourists yearly. There are 8 national parks in Croatia, which make up for almost 8% of the total territory. There are also 11 nature parks.

The correlation of math and geography is self-evident. Math is all-present in geography. A great deal of data is based on mathematical calculations and precise measurements of the Earth's shape, size, movements, surface, land to sea ratios etc. All this data is inseparable from math and its findings.

In this presentation I will point out some tasks from the area of geography, which could never be solved without mathematical skills such as assignments with ratios where the map scale, distance calculation, density of population and natural changes are mentioned.

In conclusion, we can safely say that geography relies on math and that math is essential for various calculations, estimates and data processing.

MP29. NEW IDENTITIES OF K-TH ORDER PERRIN SEQUENCES

Aleksander Bosek
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Perrin sequence was introduced by Edouard Lucas in 1878, who note p divides a_p for primes p. Subsequently, in 1899 the sequence was mentioned by R. Perrin. Perrin's name was given to it by B. Shanks and W. Adams in 1899.

At the first we describe our motivation by proving timelines of the subject presented in selected works of (in alphabetical order) A. Nowicki, A. Schinzel, A. Stakhov, A.F. Horadam, A.G. Shannon, A. N. Philippou, K. Atanassov, D. Jarden, F. Luca, I. Włoch, K. Conrad, R. Wituła, T. Koshy, T. Ward, and V.E. Hoggatt.

Next we introduce a type of linear recurrences,an extension of the Lucas sequence, which is straightforward generalization of Perrin sequence.

On OEIS there are only mentioned 4th, 5th, 6th orders, which respectively are A050443, A087935, A087936. It appears they have many common properties. 3th order (Perrin) sequencewas investigatedrelatively extensively.

We prove new common identities linear and nonlinear for those sequences. We show findings applied to 3th , 4th , 5th and 6th orders.

We present generalized nested radicals formula related to the sequences.

Further we prove results linking determinants of matrices having Perrin as entries elements of k-th order Perrin recurrences and discriminant of Selmer polynomial X^k-X-1.

Research methods applied to study properties of k-th order Perrin recurrences can be also applied for studying other linear recurrences.

Proposed results show that Selmer polynomials have very many noteworthy properties and encourage us to study them deeper.

MP31. SOME RESULTS ON THE APPLICATIONS OF MARKETING IN VIEW OF GAME THEORY

Parsa Maleki
Shahid Majdzadeh Highschool, Iran

Peter Drucker: “Success is determined by customer not by producers”

Marketing is the study and management of exchange relationships. Marketing is used to create, keep and satisfy the customer. With the customer as the focus of its activities, it can be concluded that marketing is one of the premier components of business management than the other being innovation. The historical development of marketing can be traced back to ancient days during barter trade. However, significant improvements were made through industrial revolutions in the 18th and 19th centuries. Game theory as a marketing tool is mainly used in economics, political science, and psychology, as well as in logic and computer science. The Nash Equilibrium theory is also a concept of game theory where the optimal result of a game is one where no player has an incentive to deviate from his chosen strategy after considering an opponent's choice. Overall, an individual can receive no incremental benefit from changing actions, assuming other players remain constant in their strategies. In this paper, the different mathematical models of game theory used in marketing are introduced and compared with each other. In this regard, some interesting examples and other applications of marketing will be mentioned.

MP33. A SOLUTION TO EVERYTHING

Konstantin Popov,Pavel Burya
International School of Moscow, Russia

Through the centuries, founders of algebra, such as Al-Khwarezmi, fathers of mathematical analysis - Leibniz and Newton - and many other extremely talented Mathematicians such as Leonard Euler and Gauss were attempting to unearth one general and functional method for solving equations of different complexities.

Many virtuosos of Mathematics were all chasing a sole, seemingly achievable dream. This was until Isaac Newton discovered a seemingly evident, yet rather revolutionary method of solving equations through graphing and finding the slopes at a chosen point. This would aid you to find the root of the equation, and through iteration allow you to obtain a rather accurate answer.

Although at the time it was not evident, nowadays modern calculus courses do not leave this powerful tool out of their syllabi, with its astonishing ease and precision being unprecedented and unmatched by similar methods like the secant method.

We will not only be unravelling one of the many existent yet less well-known applications of differentiation in our presentation, but also inspiring aspirational Mathematicians with challenging content in a digestible manner. We will be providing a polynomial differentiation programme - written in Pascal and “designed” in Bohrland Delphi - in order to rapidly provide a precise answer - local root of the function - using Newton’s method.

MP34. BEATING WORLD RECORDS USING MATHEMATICS

Lucia Hosein
International School of Moscow, Russia

Over the years, the competition for breaking sprinting world records has become fierce. Different athletes from around the world are spending more money and going to greater lengths in the pursuit of glory and success, running faster by the year.

But, have you ever dreamed of becoming the next Usain Bolt?

In this presentation, I will try to make such dreams possible, using Mathematics. I will calculate my speed per hour, BMI and other properties with regards to my general health. Furthermore, I will compare professional athletes' attributes to my own to see how much I need to improve to become the best athlete in the world. One of these athletes - Wayde van Niekerk - holding the world record for the 400m at 43.18 seconds in 2016 has defeated some of the most famous world champions in history, including Michael Johnson and Usain Bolt. By analyzing his attributes, could his record one day be beaten?

As well as what I have mentioned above, there will also be a few tips on how to improve your personal running records and general health so you can strive for your own personal athletic glory. Finally, using all the information I have gathered, I will compile the statistics of different athletes to find what the optimal attributes are.

MP35. COUNTING WITH CATALAN NUMBERS

Adewumi Feyikemi, Dawodu Naimah, Alayande Emmanuel
The Concord School, Nigeria

Suppose an even number of people are seated around a circular table, in how many ways can all of them simultaneously shake hands with another person at the table without anyone's arms crossing?

In how many ways can you triangulate a regular polygon with n + 2 sides?

The solutions to these problems and many more such problems are found in a beautiful sequence of numbers called the Catalan Numbers. The Catalan numbers are a sequence of natural numbers that appear in several counting problems in combinatorics.

In this work, we examine the origin of Catalan numbers, how they can be derived and their various properties.

We also investigate how and where Catalan numbers show up in many mathematical problems and their various applications in real life.

MP36. MATHEMATICS AND RIGID BODY

Oleghe Godwin, Akerele Abdulsattar, Uthman Hameedah, Okeoma Isabella
The Concord School, Nigeria

We will begin our study on the representation of the configuration of a rigid body by focusing on the orientation only. The approach to representing the full configuration of the rigid body is analogous. We will consider two frames and use the concept of matrices to show how a rigid body can be translated and rotated.

MP37. A RIDE YOU WILL NEVER FORGET

Andreana Vanezou, Giorgos Antonaras, Ioannis Panayiotou
The GC School of Careers, Nicosia, Cyprus

Have you ever ridden a rollercoaster? Oh, the screams of happiness! It all begins with the adrenaline rush right before you buckle up on your wagon. But wait.., it begins even before that.

What if I told you that all this fun and excitement would not be possible if it wasn't for the magic of Mathematics? What does math have to do with thrilling rollercoaster rides you might ask? Well put your seatbelts on because this is going to be a bumpy ride!

Firstly, the team of designers, and mathematicians have to make all possible calculations to make sure that the ride is physically possible to create. So, there are lots of important mathematical factors that need to be considered before building any type of rollercoaster. Let's take a look at speed and velocity. It's very important for them to know the terminal velocity of the train without going off the tracks. Secondly, they need to measure the length to calculate precisely the force needed. Height follows, as designers have to forecast the break power that would be essential. Lastly, let's not forget everyone's favorite, the 'fun factors'. Meaning the sudden drops, the breathtaking curves and the 360 loop. Extremely careful mathematical calculations are necessary to secure a safe and fun experience for everyone.

So, next time you are at a theme park ready to go on your favorite wild ride remember us as we assure you that you are in safe hands, so sit tight and enjoy the ride!

MP38. MATHEMATICS AND LIFE

George Savva, Nearchos Miltiadous, Charis Chari, Ioannis Petevinos
Regional Gymnasium of Nicosia in Malounta, Cyprus

Mathematics are everywhere in our everyday life. Numerical and logical thinking play part in our everyday activities, and in many others. A good understanding of mathematics in everyday life is essential for making sense of all the numbers and problems life throws at us. Math helps us with our finances. Math can be helpful for balancing our budget because we can have a good understanding of how to make sure that our costs are less than the money we have. Balancing ones bank account, for example, is an important life skill that requires math in order to subtract balances. When visiting a foreign country is important to have knowledge of currency conversion, because only by converting it back into our currency we will know if something is expensive for our budget or not. Moreover, math is connected with cooking as well. When someone cooks he needs to measure the ingredients in terms of teaspoon, tablespoon etc. For example, preparing meals for many people, will need the measurements accordingly. In conclusion math is a global language. Mathematical law doesn't change because someone has a different religion, country or beliefs. In reality math is a necessary part of our life and helps us understand the world much better.

MP39. THE AREA OF SURFACES WHICH ARE BOUNDED BY THE "BLACK HOLE" FUNCTIONS

Bogdan Branisteanu, Darius Feher
"Mihai Eminescu" National College Satu Mare, Romania

We will define a class of functions which, because of their properties and their graphs, we named "Black Hole" functions.

In this paper we will find the area of surfaces bordered by these functions ("Black Hole" functions) and we will establish a correlation between these areas and Riemann Zeta function (ζ).

MP40. SOME INFINITE PRODUCTS

Arteni Dan, Podina Tudor
"Mihai Eminescu" National College Satu Mare, Romania

The concept of an infinite product (or sum) is mysterious and intriguing. How can you multiply an infinite number of terms? And what is the result?

In this paper we obtain some results using the monotony of some functions. Then we show the relation between the result and the terms of the product.

In the end, we will calculate the sum of some series using the results of infinite products.

MP42. UNDERSTANDING MUSIC THROUGH MATHS

Constantinos Gallis, Riho Pallum, Georgios Roupas
St. Catherine's British School, Greece

We have always been interested in music; we listen, compose, and play music any chance we get. These past few years, as our maths skills have developed, and our knowledge of music has grown, we have seen an undeniable link between the two fields, as we began understanding how rhythm works by looking at ratios and sequences. For our study we will explore the links between maths and specific pieces of music, and see in what ways we can understand different time signatures found in Art Rock, and in various traditional genres of music such as Greek Zeibekiko. We will also explore the musical effect of using non-traditional time signatures, like 5/8 time, 5/4 time, 9/4 time, and 7/8 time, and explore the different ways in which we can understand various polyrhythms. We will also explore how musical swing can be understood in terms of ratios and percentages, and demonstrate that by using mathematics we can express musical ideas more precisely than in traditional sheet music. Using this same method we will also convey alternative ways in expressing different note values. Throughout the presentation we will use sections of songs to demonstrate how these ratios make up the backbone of both traditional and modern music.

MP43. THE MAGIC OF NUMBERS

Vretta Theodora, Kaltaveridou Maria
Diastaseis Private School, Greece

The world of numbers has always been interesting in humans, even though the majority of people cannot understand its magic. This misunderstanding led people to believe that numbers are something exotic and something that gods sent to them. There was a belief that we can predict the future by analyzing the numbers as like observing the stars. Nowadays these beliefs do not exist anymore. Numbers are playing a vital role for people and they are a tool for helping people in everyday life. We can calculate length, weight and money by using them, in order to find more efficient ways to improve our life quality. That does not mean that their magic does not exist. There are some numbers that have very strange use. Irrational numbers, pi and prime numbers have always been the talk of the town among mathematicians.

MP44. CRYPTOLOGY'S JOURNEY

Kaltaveridou Maria, Vretta Theodora
Diastaseis Private School, Greece

Cryptography has been around for thousands of years. It has decided wars and it has been the core of communications network. Cryptography is a method of protecting information and communication through the use of codes so that only those for whom the information is intended can read and process it. Also, cryptology can be found in computer science Cryptography refers to secure information and communication derived from mathematical concept. A set of rule based calculations called algorithms, transform messages in ways that are hard to decipher. These deterministic algorithms, are used for cryptographic key generations, digital signing, verification to protect data privacy web browsing on the internet and confidential communication such as credit card transaction and email.

MP45. THE SHADOW'S HIDDEN MESSAGE

Taekhyun Kim, Dongyoung Kim
International School of Moscow, Russia

Thales is our inspiration. He was visiting Egypt, the home of Mathematics, to further his studies. According to legend, he was walking alongside a pyramid with the Pharaoh, when the Pharaoh ordered Thales to measure the height of the pyramid. He somehow managed to do it. The question is, how?

All Thales had was a wooden stick. No rulers, no safety equipment to climb the pyramid. With a wooden stick, Thales thought of the problem in terms of ratios and this made the challenge possible.

Thales stemmed the stick to the ground and observed the length of the stick's shadow. He realised that the ratio between the length of the stick's shadow and the height of the stick is equal to the ratio between the length of the pyramid's shadow and the height of the shadow. Acknowledging this, Thales measured the length of the pyramid's shadow and calculated the approximate height of the pyramid.

The goal of our project was initially to measure the iconic landmarks of Moscow, by using the aforementioned method. However, due to weak sunlight and various other factors, we failed to measure any shadows.

We learned two things due to the failures. One, we were able to find out the appropriate conditions needed for this method to succeed. Two, we studied other ways of measuring high architectural structures, such as using trigonometric ratios and perspectives.

MP46. BLACK HOLES

Gregory Chizhov
International School of Moscow, Russia

Black Holes are one of life's great mysteries; many have been perplexed by the unknown composition of a black hole, and there are still many questions unanswered. So far, we have discovered that a black hole can be as big as the size of a million suns or as small as an atom!

Did you know that Stephen Hawking was not the first person who discovered Black Holes? In the 18th century, two men called John Michell and Pierre-Simon Laplace noticed such strong gravitational fields in space that even light could not escape from it. Once, even Einstein noticed something strange when staring into the stars - a light changing its own direction! Join me in my presentation and I will lead you on a historical journey of Black Holes. I will also discuss the latest evidence relating to black holes.

MP47. ABSOLUTE ZERO

Taekhyun Kim, Dongyoung Kim
International School of Moscow, Russia

Scientists know the temperature of the absolute zero, which is 0 Kelvin (-273 ℃). Absolute zero is when the energy of an atom becomes zero. The more energy in an atom, the greater the temperature created. It is not possible to find a temperature below absolute zero because the energy in an atom is absolutely minimized at absolute zero. The question is then, what is the highest temperature possible?

Absolute hot is the maximum temperature that is possible. Unlike absolute zero, the temperature could go really high and humanity has yet to recreate a temperature that is close to it. The Sun's core is 16000000 ℃ and the nuclear weapon could go up to 350 million ℃! The highest temperature humanity actually ever created was the hydrogen bomb which went up to 200 million ℃.

In our presentation, we will tell you about some of the highest temperatures ever recorded, such as that of the Sun's core and the exact theoretical temperature of absolute hot. We will explain how the scientists were able to calculate the temperature of the 'absolute hot' theoretically.

MP48. HOUSE MARKET PREDICTION POST MARS COLONIZATION

Achnioti Myrto, Fidawi Jad, Kybritis Yiannis, Saad Roy
St Catherine's British School, Athens, Greece

Imagine waking up 54.6 million kilometers away from your house, on a different planet. As ludicrous as it might sound, SpaceX is working towards making Mars habitable and in the next decade a crew of specialized engineers is said to land there so as to facilitate the move of Earth civilians to Mars. Could you imagine decorating your brand new house on a different planet? What will happen to your old one? In fact, what will happen to the whole housing market back in the USA when the first 'moves' commence? In our project, we will be looking at how we can predict the state of such a massive market after such a massive change using mathematical tools applied in economics. More specifically, we will be using 'phi,' otherwise known as the 'Golden Ratio' and the Fibonacci sequence; a method which has been and is still used in predicting market states.

MP49. MATHEMATICS AND SPACE

Panteleimon Tassopoulos, Ioannis Angelo-Tassioulas, Nikolaos Pollalis, George Pavlakis
St. Catherine's British School, Athens, Greece

Space, the final frontier - for centuries humanity has been fascinated with the stars. Within the past century we have developed the ability to appease our innate curiosity and travel beyond Earth's gravitational field. However, the process required in being able to go where no man has gone before finds its basis in mathematics. From classical physics to the calculation of cosmic movements, mathematics plays an integral role. How do scientists calculate the position of the moon and predict its movement? How do scientists take into account the position of rockets and project their movement during those crucial moments of breaking Earth's gravity? The answer to all this is related to a very specific field of physics- celestial mechanics, the study of the motion of objects in outer space, an application of classical mechanics in the field of astronomy. When space agencies around the world plan out their space voyages with accuracy and confidence, they invariably use the physical theories thereof, which are predicated on Newton's Laws of Motion. In this presentation, we will give an axiomatisation of newtonian dynamics and, utilizing the mathematical tools provided by differential and integral calculus, make a mathematical derivation from first principles of the equation of motion of a variable mass system, a special case of which is the Tsiolkovsky rocket equation. We will then proceed to calculate how much fuel is required to reach escape velocity for a typical rocket where the Earth's gravitational field is considered.

MP51. CONTINUED FRACTIONS

Ivayla Ivaylova Radkova
125th SU “Boyan Penev”, Bulgaria

First of all I am going to explain what a continued fraction is and I am going to show how we can turn a rational or irrational number into a finite of infinite continued fraction (rational numbers have finite representations and the irrational – infinite representations). Each continued fraction has convergent values and when we “dive deeper” in the continued fraction the convergent value becomes closer to the value of the given continued fraction.

The presentation is also going to include some of the continued fractions’ history and people that have worked on these fractions, like Archimedes who used the continued frictions to find the approximate values of some irrational numbers. There are some interesting representations of π as infinite continued fractions (π is irrational) so I am going to present them too. We are going to take a look at Euler’s theorem and the golden sequence which is the only number whose infinite continued fraction and every convergent includes only one number – one.

Finally we are going to take a look at the significance of the continued fractions in mathematics and in the world around us, people don’t accidentally say that God is a mathematician.

MP52. TYPES OF SPACES AND TRANSFORMATIONS BETWEEN THEM

Teodora Vasileva
125th SU “Boyan Penev”, Bulgaria

Addressed are the properties of the main geometric spaces: Euclidean, elliptical and hyperbolic. It is shown that according to the special theory of relativity, the physical space is hyperbolic, and we live on an elliptic surface on the Earth. Also it is shown that human visual space is hyperbolic. Further addressed is the difference between the geometric, physical and visual space.

Below are presented the different methods of transformation between the spaces, both in terms of their dimension (the Mobius strip into Klein bottle), and the types of spaces. Briefly presented is the general theory of the coordinate system on a surface. Attention is drawn to the introduction of coordinate systems in the three basic geometric spaces. Also shown is the role of the geometric space in the perception of the physical world. Furthermore the transformation of physical space to the geometric and the geometric to mapping space has been examined and finally, the Cartographic modeling space to visual space.

The practical application of the geometric space, in particular ellipsoid geometry, in the development and use of cartographic projections has been examined in greater detail. It is shown that map projections define specific geometric spaces which do not fulfil the basic properties of the geometric space defined by Poincaré. Also described are different ways of developing specific cartographic projections (discussed are the basic cartographic projections), the predefined requirements and the study of the deformations, which result from the different projections.

MP53. CRACKING THE JOSEPHUS PROBLEM

Seva-Mei Anagnostou, Jason Bonas, Zoe Kountouri, Ioanna Tsoktouridi, Marina Fragkouli
The Moraitis School, Greece

Imagine that you are in a game show: If you sit in one specific place in a circle, then you win one million dollars. If you sit in any other place then you do not win anything. Every second (or third, or nth when we generalize the problem) person is eliminated. So where would you choose to sit?

Josephus, a Jewish historian, faced a similar problem, when he had to avoid being executed by sitting in a circle of 41 people with every third man being executed. Luckily, he solved the problem and survived.

Similarly, we wish to count on our counting skills to win the money. We calculate beforehand the seat we should occupy, but this time for any number of possible contestants, in order to win the one million dollars.

MP54. MATHEMATICS IN CRYPTOGRAPHY

Khalid Mashal, Madeleine Rosenqvist, Talemwa Nanyange
Turku International School, Finland

Cryptography is the writing of codes to protect information through the use of encryption and decryption. Cryptography is a set of mathematical functions to create algorithms called ciphers that turn basic text (often referred to as plain text) into ‘ciphertext’. Ciphertext is hard to decipher as the original letters are replaced with letters, numbers and symbols through mathematical equations, thus making the information encrypted and transformed into formats that cannot be recognized by unauthorized users. Most encryption is based on number theory, exponential math, Euler’s theorem and a lot of abstract algebra that make the ciphers. With this method, information such as passwords, emails, private data, and even cryptocurrency such as bitcoin can be protected. Cryptography dates back centuries, one of the earliest being the Caesar cipher which is one of the simplest ciphers for encrypting. These ciphers were handwritten messages coded so unintended recipients would not be able to understand the message. It is very simple so not very reliable, but we believe should be taught to students entering the world of computer science, giving them a vague idea and introduction to encryption. Today, most cryptography is digital and is even used by corporate organizations, such as the military and the government to protect sensitive information.

MP55. MATHEMATICS AND PHILOSOPHY

Juan A. Monge-Navarro Otero
Turku International School, Finland

The following work will attempt to present to the reader the topic of Quasi-Empirism in Mathematics. Normally mathematics and empirism wouldn't go together that well because in its most basic form empirism is a philosophical theory that basis all knowledge through sensitive experience. But Quasi-Empirism attempts to underline the relationship between math with physics, social science and computational science. Also through this theory we could approach problems in empirism such as realism and necessity of application. For philosophers like Laszlo Kalmar all mathematical axioms are in a way extracted from empirical facts. This would mean that empiricm is essential to all mathematical axioms and since axioms are the building blocks of mathematics Empirism is something which we would have to understand if we want to fully understand Mathematics. So in a nutshell the following work will present to the reader the influence of Empirical thought towards Mathematics.

MP56. MATH AND PHYSICS IN BILLIARDS (POOL)

Dimitar Lazarov
125th SU "Boyan Penev", Bulgaria

I am going to write about math and physics in billiards (or pool). First I am going to cover angles – the simplest part. Then I will move to whit what force to hit the ball in order to move it a certain distance and in order to hit the next ball at a certain direction and distance. I am going to account for cue ball spin, friction, air resistance (even though it's almost 0). Then I will add about at where to hit the cue ball so it will go a certain direction. And just before the end how should you hit the cue ball in the air so it does the right thing. And in the end I will explain all conclusions about how to play better, at least in theory (even to 'cheat') and how to make some 'trickshots'.

MP57. CONICS AS LOCI AND ENVELOPES

Martin Dimitrov, Gergana Peeva, Borislav Stoyanov
125th SU “Boyan Penev”, Bulgaria

The project is focused on a common representation of conics as loci and envelopes. This approach is based on similar algorithms designed by dynamic geometry software for parabola, ellipse, and hyperbola, respectively. Any algorithm initially produces separate point from a particular conic as intersection of two lines depending on one parameter. The whole conic on one hand represents the locus of points that satisfy the condition of the conic definition; on the other hand it is the curve described by the intersection point when the parameter changes. After some locus points are constructed, one of the lines in the algorithm is ignored and the other one is left to move according to the change of the parameter generating one-parametric family of lines. The envelope of this family coincides with the locus. Thus, the conic nature becomes dualistic: composed of real points (the locus) and just a phantom that surrounds the one-parametric family of lines (the envelope). Such duality allows to give easy proof of the reflective property of the conic. All statements are illustrated by GeoGebra applets.

The project is done in the frame of the Educational and Research Program ‘Chernorizec Hrabar’ of the Institute of Mathematics and Informatics (Bulgarian Academy of Sciences) and 125th Secondary School “Boyan Penev”, Sofia, Bulgaria, with the financial support of BULATSA.

MP58. 3 6 9 THEORY OF NIKOLA TESLA

George Toumbas, Notis Tzionis
American Academy Larnaca, Cyprus

Nikola Tesla is considered by many, until this day, the greatest scientist that has ever existed. Tesla took into account the numerical patterns that occur in the universe, such as in star formation, the development of embryonic cells, and many others that some call “The Blueprint of God.” Our team is exploring the significance of the numbers 3, 6, 9 and how, according to Nikola Tesla they are the key to free energy. An example of the specialty of the three numbers, lies in Vortex Math. Vortex Math is a repeating pattern: 1, 2, 4, 8, 7, 5, 1, 2, 4, 8, 7, 5, 1, 2, 4, and so on to infinity. Here, numbers 3,6 and 9 do not exist. These numbers represent a vector from the third to the fourth dimension, which is called the “flow field.” This field is a higher dimensional energy, which has an influence on the energy circuit of the other six numbers. This was considered by Tesla the secret key to free energy! More examples include even those three numbers expanding to infinity itself. If we gather all the single numbers (1,2,3,4,5,6,7,8,9) around a circle with equal distance between them and draw the infinity sign inside the circle we can see that the sign is pointing in all numbers except 3,6,9. By connecting those 3 numbers together we can form again a triangle formed inside the circle. “If you knew the magnificence of the three, six and nine, you would have a key to the universe.” – Nikola Tesla

MP59. TINDER STARTER GUIDE

Antonia Asimakopoulou, Alexandros Contomichalos, Vicky Deligianni, Angela Pilioura, Nikos Skouloudis
The Moraitis School, Greece

All of us have faced the dilemma of choosing something that is available at that moment or rejecting it and wait, hoping that something better would come. This scenario can be depicted by the use of “Tinder”, a dating app which helps users find their match online. However, is it possible to find a way to maximize the chances of choosing the best match?

In this paper, we discuss the “Secretary Problem”, which examines the number of candidates that should be rejected in order to hire the best one. Our aim is to select the best potential candidate amongst a pool of applicants. While reviewing a candidate there are two options: We can reject him/her and move on to the next person, knowing that we cannot go back and choose them later on or, if we believe that the candidate in front of us is the best one, we can choose him/her. In case we choose to hire a person, the procedure stops. We analyze the way we can estimate the best time to take action in order to maximize the probability of selecting the best, by using the Theory of Optimal Stopping.

MP60. THE CONFIDENT GAMBLERS

Ara Artinian, Christopher Moulakis
The Moraitis School, Greece

Imagine the following game: Two players, player A (you) and player B (we) flip a fair coin repeatedly until a pattern, that one of us has selected, emerges. Depending on the pattern you choose, we choose another one and we are confident that our probabilities on winning are greater! If you choose tail-tail-heads (TTH) then we choose HTT.

If, on the other hand, you wish to choose HTT, then we shift to HHT.

If, again, you choose HHT, then, this time, we choose THH.

And the best part: If you happen to copy that and choose THH then we bet on TTH!

Hold on for a second! How is this possible? This exact pattern was the one that you first lost with. However, we insist on selecting it. In fact, in our presentation, among other things, we will prove that this is actually possible and indeed we have better chances in winning!

MP61. THE FIBONACCI SEQUENCE

Astrid Hofwander, Engla Sundstrom
Polhemskolan, Sweden

Is there a way to calculate number *n* in the Fibonacci sequence, without counting every number before the one you are interested in? The answer to that question is yes, there is a way to do that, by using a explicit formula. That way you don't have to know the two previous numbers.

The Fibonacci sequence is a sequence where every number is the sum of the two previous numbers, with the two starting numbers being zero and one. The sequence is very well known since it can be found in surprisingly many things in nature. For example the placement of the petals on many different kinds of flowers and plants follows the fibonacci sequence.

In our presentations we are going to talk about fibonacci and reconstruct a recursion formula into a explicit formula to calculate the number *n* in the Fibonacci sequence.

MP62. BEAT THE BLACKJACK DEALER

Anna Prodromou, Kyprianos Kythreotis
The Grammar School, Nicosia

Many people consider winning or losing when playing cards is all about luck. What if I told you that it all depends on simple mathematics? Blackjack is one of the most widely known casino games in the world. By using simple math tricks you can bring "luck" to your side! When someone mentions card counting, you probably think of people being removed from the blackjack table, but that is not the case! In fact it is not illegal as long there is no help from an external factor! Isn't that exciting? With this mathematical strategy you can avoid losing money and know when to bet so you gain a lot of profits. All you need is a lot of practice and to be focused, then you can walk out of the casino with a sizeable amount of money and amaze everyone!

MP63. SHOULD WE TRUST OUR COMMON SENSE?

Maria Papageorgiou, Chrysovalanto Grigoriou, Athina Strati
The Grammar School, Nicosia

Maths, the only science not dependent on assumptions, seems perfectly consistent, the only knowledge that we can take for granted. Is it ever possible for a principle utterly based on deductive logic, to face contradictions? Seems contradictory! This work analyses two of the most brain bending paradoxes and pseudo-paradoxes. When cutting a piece of chocolate in a particular way, it seems like we have infinite chocolate. Numbers seem to (dis)appear when calculating the areas of certain shapes using consecutive Fibonacci pair dimensions. Reasons behind that are examined. Can a process without a last step be completed? As absurd as it may sound, the answer is yes. This is known as Zeno's paradox and proofs for this are given in this work. If a hotel with infinitely many rooms is full, can it still take in more guests? The answer is again, yes. It is simply a matter of shifting the hotel guests rooms.

MP64. WHEN PAPER MET MY FINGERS

Marianna Vassiliou, Evanthis Vacanas, Sotiris Vacanas
The Grammar School, Nicosia

MES airlines. Welcome on board! Nowadays, most youngsters can barely make a rough estimate of their toy store bills before they check out, let alone automatically multiply numbers in their heads. But what if they could subconsciously perform equations, just by doing the simple act of folding pages from their notebooks? Believe it or not, the art of origami is significantly linked to mathematics. Attempting to draw Mona Lisa during Art class is quite an experience, yet has anyone ever told you that you can still create something astonishing, without holding a brush nor paint and simultaneously being able to explain the Maths behind it? Mathematics is everywhere and anywhere! In 200 AD, paper was discovered as a cheap alternative to silk and as soon as it was brought to Japan, Akira Yoshizawa introduced folding it as a way of teaching his employees about angles, lines and shapes. It soon triggered the interest of numerous mathematicians, including Toshikazu Kawasaki and Jun Maekawa, whose developed theorems formed the basis of origami art. Who said painting Mona Lisa is the only remarkable masterpiece, worth remembering someone for? Well, from simple paper airplanes to more intricate paper creations, origami takes Maths to the next level. Join us on this paper airplane to Origami land and let us guide you through the magic of trisecting an angle, proving $a_1 + a_3 + a_5 + ... + a_{2n-1} = 180$ as well as $ax^2+bx+c=0$ and much more. Have a safe flight!

MP65. DEDUCTIVE DATABASE APPROACH TO AUTOMATED GEOMETRY THEOREM PROVING AND DISCOVERING WITH JAVA GEOMETRY EXPERT

Kostas Georgios-Alexandros, Bampatsias Panagiotis
Varvakeion Model High School, Greece

The purpose of the present paper is to show that the development of the computer program JGeX enables one to solve many elementary and non elementary problems of classical geometry. Classical methods show the beauty of geometry, and provide better insight into the situation and better understanding of the problem. However, computer methods allow one to solve complex elementary and non elementary problems. JGeX is a software tool for dynamic geometric drawing and automated geometric theorem proving and discovering. The dynamic geometric editor has the following functions: (1) geometric input of geometric diagrams and statements for the prover, (2) dynamic geometric transformations and measurements, (3) animation and loci generation. JGeX is also an efficient computer program for geometric reasoning, implementing five proving methods, including algebraic ones. This fact makes this software one of the most powerful automatic proof systems nowadays. The prover of JGEX has been used by many researchers to deal with various kinds of geometry problems. Our goal is to make clear how JGeX can be used to help the users prove a theorem, even if the program is not able to make a direct proof, by using its property library. The educational value of this tool is of paramount importance and for this reason we will also present practical examples of how JGeX can assist students in the learning process. The theorems we demonstrate are selected from the collections of Grozdev S. and Nenkov V. of the Bulgarian Mathematical Institute and Lygatsikas Z. of Varvakeion High School of Athens.

MP66. LINEARIZATION

Yavor Georgiev
125th SU “Boyan Penev”, Bulgaria

The presentation includes concepts of function, interpolation, approximation.

Presentation of the rounding method when calculating a function.

Explanation of interpolation and approximation.

Linearization as type of approximation.

Graphic representation of interpolation and linearization. Calculation of a linear function by tangent to a given point of a complex function.

First derivative of function.

Finding a square root by means of linearization. Problems and their solution.

MP67. WHEN MATHEMATICS MEETS FASHION

Marina Leonida, Orthodoxia Georgiou
American Academy Larnaca, Cyprus

Mathematics is a very rich and human subject, an art that enables us to see deep interconnections in the world. It is pretty much in everything you do. It makes our life orderly and prevents chaos. Math is also a crucial element of fashion including measurement, design, product development, production and merchandising. Without a doubt, measurement is a key part of fashion as fashion designers have to measure patterns, angles, the amount of fabric and what size the clothing is. Measurements in fashion can be done in inches, fabric yardage or cm for accessories. If we couldn't use math in fashion, then the clothes that we wear today would not fit correctly. In addition, an understanding of geometry and symmetry is needed when mapping a two-dimensional pattern that has to be designed to fit on a three-dimensional body. Furthermore, product development, production and merchandising need mathematics to process product pricing, logistics and cost. Math is used for accounts – payable, receivable, tracking company expenses and managing budgets. As we realize, math plays a very important role not only in measurements and designs but also in the financial state of the fashion world.

MP68. MATHS IN BEAUTY

Eleni Apostolou, Georgia Haili, Myrofora Markidou
American Academy Larnaca, Cyprus

Some people say that mathematics is a factor of beauty. Oh well, if you don't believe so, we will try to convince you! Mathematics and nature work together to create something beautiful and different, like our faces. This is because according to how big or small are your features (e.g. eyelashes, eyes, lips) {measurements} and how your features are shaped (e.g. the shape of your face, lips, nose, eyes) {geometry} those things affect how beautiful you are. The mask of the ideal human face is based on the golden ratio. The length of the nose, the position of the eyes and the length of the chin are claimed to conform to some aspect of the golden ratio. For example, if you take a face and measure it with a protractor then you will see that the one side of the face is the same with the other side of the face. Why? Because of the golden ratio. Also eyes have the same length between them and the nose, which this makes the ideal human mask. The golden ratio is based on Fibonacci numbers, where every number in the sequence is the sum of the previous two numbers: 1, 1, 2, 3, 5 ,8 ,13, 21...

MP69. JUST BEFORE SLEEPING

Prokopis Georgiou
American Academy Larnaca, Cyprus

Have you ever imagined how numbers got their shape and their meaning? Well, in this presentation you will learn about how Arabic numbers were originally created and the logic behind them. It is very simple and quite creative to do so. My presentation is based on an early Arabic geometric design, where each number contains its own number of angles-corners. For instance, number one (1) has one angle, number two (2) has two angles, number three (3) has three angles and so on. But when we get to number seven (7) you will see that number seven has a line through the middle and the bottom of it. But that's the way they wrote it in Europe. Number nine (9) and five (5) have a curved line but now it has been reduced to a simple curve. The logic involved still applies. The idea of the title “Just before sleeping” came to my mind before I went to bed while I was counting sheep in order to fall asleep. While I was counting them the idea of how numbers got their shape came into my mind. I researched it. I thought of it and I would really like to come and present it to you as well!

MP70. SOROBAN & ANZAN - THE SECRET OF MENTAL MATH WITH THE JAPANESE ABACUS

Noah Newton Obermair
Austria

The “Abacus” translates to “counting frame” and is a wooden frame, which holds columns of beads. As an efficient and accurate mathematical calculation tool it is used since ancient times and can be seen as kind of an “ancient computer”. The Japanese modernised the original abacus and gave it the name “Soroban”. In Asia nowadays the Soroban got rediscovered as an efficient learning tool to teach arithmetic to children in the competitive market of “After school Curriculums”.

As students learn to calculate by moving the beads on the Soroban, they begin to form strong mental images of these same bead movements in their mind and eventually no longer need the physical Soroban. They use the Soroban method as a unique visual calculation system which they call “Mental mathematics”. Students are trained to be able to visualize the abacus image clearly in their brain, manipulating this image to perform quick, accurate mental arithmetic calculations.

Abacus mental arithmetic is based on brain imaging, also known as the image memory. This is how humans see and capture the images of objects similar to a camera.

This presentation will provide a small overview on the historical development of the Abacus; the philosophy and technique of visual memory on which the Soroban Mental Mathematic method is based as well as an insight into the step-by-step learning process to perform basic mental arithmetic calculations which I trained first-hand during my stay in Asia where I enrolled at a Soroban course over several weeks.

MP71. LEARNING MATHEMATICS FROM ANTS

Patrik Aleksic, Patricia Baros
Prva Rijecka Hrvatska Gimnazija, Croatia

Ants, who are mostly considered pests, are actually among the most intelligent creatures currently living. They communicate, cooperate, teach, capture slaves, get involved in ant wars, build cities... but most importantly – they use maths in all of that. While describing some of the experiments undertaken (in which no ants were hurt) we will be looking at some highly intellectual decisions and acts of 'just' a colony of ants and present our amazing results.

MP72. THE MATHEMATICS BEHIND THE GAME OF “ROCK-PAPER-SCISSORS”

Natali Marinkovic
Prva Rijecka Hrvatska Gimnazija, Croatia

As it is right now, rock-paper-scissors is one of the simplest games known to man. Usually, it is played between a couple of people who simultaneously form one of three shapes (rock, paper or scissors) with their hands. In this presentation, I aim not only to show the mathematics behind the game of rock-paper-scissors, but also to prove that my original statement (“one of the simplest games”) is not exactly true. I will do this by showing you my own variation of it, and some a-lot-more-complicated variations that have previously been created, as well. Furthermore, I would like to present some statistics that I have gathered through observing my fellow students to play multiple games of rock-paper-scissors.

MP73. HOW TO WIN IN PAC-MAN

Andrej Bozic, Luka Zmak
Prva Rijecka Hrvatska Gimnazija, Croatia

Games are used for fun but there is always a little bit of math that you can learn from a game. When you were young, and maybe even now, you have played the arcade game Pac-Man. Hoping to collect all the „Pac-dots“ you would go through the labyrinth like a headless chicken. Sometimes you would succeed, but most of the time you would fail and you have surely asked yourself if it is possible to constantly complete levels. If you lost you would blame it on your bad luck, but luck has nothing to do with this game because the movement of the ghosts who chase you is strictly defined and predictable. The ghosts' targeting schemes determine their movement and with the understanding of the schemes you can finish every level. Even when you complete a level your next challenge was to complete it in a shorter period of time not repeating the path you once used, and with continuous efforts you might have come to some conclusions, but you could have done it much faster by using the knowledge of mathematics. Mathematics gives you a new perspective on the game and it proves that for successful playing you need logic, not luck.

MP74. MATHEMATICS IN CRYPTOGRAPHY

Nickolas Farmakis
American Academy Nicosia, Cyprus

Undoubtedly, cryptography is an essential tool for modern life. In today's world, there are countless examples of areas where cryptography is vitally needed. Blockchain, internet security and internet shopping are only a few examples of where cryptography is necessary. However, does cryptography relate to mathematics? The answer is an affirmative YES! Cryptography is a rigorous science that deals with the security of the messages that are being sent and received by two parties. That is, the fundamental problem in cryptography is that at any given time, a third party should not be able to eavesdrop or manipulate a message transmitted by one party to another party. Mathematics is the tool that can be used to solve this problem, since many areas of mathematics, such as number theory, matrices and algorithms are used in cryptography. For instance, many theorems involving prime numbers are frequently applied to a section of cryptography, named public-key cryptography, which will be analyzed in this article. In this paper, cryptography will be defined, but also briefly analyzed and mathematical definitions, as well as theorems will be observed and applied to cryptography. Consequently, a clear image will be drawn into the relationship between cryptography and mathematics.

MP75. MATHEMATICS BEHIND THE ATOMIC BOMB- SUMMARY

Danae Petrides, Nadine Al Asmar
The Senior School, Cyprus

For the PowerPoint presentation Nadine Al Asmar and I, Danae Petrides, are explaining the mathematics behind an atomic bomb.

We will first be explaining what an atomic bomb is, in order for the audience to be able to follow our presentation. Then we will go on, on how they work and link it to the algebraic form E = mc2.

E = mc2, is the equation discovered by German physicist Albert Einstein and it is generally called the theory of relativity. Einstein, was able to prove that energy (E) can be calculated as the mass (m) multiplied by the speed of light (c) squared. This formula implies that energy and mass are interchangeable and it explains how matter can be converted to energy and energy back to mass again. Once the equation was revealed people saw mass in a different perspective- mass became a way to measure the total energy present in an object, even when it was not being heated, moved or irradiated or whatever else. Mass is just a super-concentrated form of energy. We will try to explain this complex theory more thoroughly in own PowerPoint presentation.

We will demonstrate how this equation is fundamental in explaining the principals of atomic energy produced by nuclear power plants as well as the atomic energy released by atomic bombs.

This formula was famously mentioned in a report prepared by the US Government in 1945 in an effort to make an atomic bomb towards the end of the Second World War. The report suggested that Einstein's equation could be used to design the bomb by using uranium atoms to split into smaller atoms and releasing a vast amount of energy. Once again in our Presentation we will explain how the equation relates to the atomic bomb.

MP76. DANCE AND MATHEMATICS / UNIVERSAL LANGUAGE (OF DANCE)

Mia Cimas
Prva rijecka hrvatska gimnazija, Croatia

Mathematics is a language, said Galileo Galilei.

Indeed, it is a language composed of symbols that are manipulated in such a way as to communicate certain relationships.

Dance is also a language.

It is composed of relationships that are manipulated in such a way as to communicate certain symbolics.

I'm going to present a story about my beloved dance and its relation to mathematics, especially:

- the dance canons based on vectors, paths, sequences and order,
- importance of focus and accent in dance, described by mathematical statistics and principles of interpolation and extrapolation.
- dance group formations and dance moves striving to describe geometrical shapes and extension of movement to infinity.

Each of these components is easily described by mathematical principles since dance is (like The Universe itself) defined by space, time and energy. It is, just like mathematics, a universal language.

MP77. 3D MODELLING

Constantinos Hadjigregoriades
The GC School of Careers, Nicosia, Cyprus

Animation is a type of media beloved by many audiences, but what you probably have not thought about while watching your favourite childhood movie, is “How was it made?” This project revolves around the use of mathematics for the creation of 3-dimensional models, as well as some information on how it is used for animation. 3-dimensional modelling has many uses other than animation, such as interior designing and architecture. Polygonal modelling remains, to this day, the most used method for modelling, which includes the use of vertices, something that is explained thoroughly in this project. Emphasis is also given on matrices and how they are used to animate 3-dimensional models, while also noting the exception of certain animation processes which involve custom physics engines.

Furthermore, the structure of a 3-dimensional plane and why it is used instead of a 2-dimensional plane is explained. The concept of primitive shapes that are often used in the creation of 3-dimensional models is presented and the various elements of 3-dimensional models, ranging from edges and faces to meshes are identified. Finally, possible errors of 3-dimensional modelling, such as a model not being manifold, are discussed. One thing is certain, after this presentation you will never look at a Pixar movie the same way again!

MP78. FROM THE TOP TO THE DROP

Constantina Shiacola, Eva Antoniadi, Marios Christoforou,Orestis Savvides
The GC School of Careers, Nicosia, Cyprus

If you think of the most exciting things to do in life, rollercoasters are potentially one of the first things that come to mind. Many people avoid rollercoasters claiming that they are dangerous. Some like, and others dislike, the adrenaline rush related to such an experience. Have you ever wondered what makes roller coasters so thrilling? As many things in life, it all comes down to mathematics!

Starting with a brief analysis of the evolution of roller coasters, emphasis is given to how the contemporary roller coaster has developed to excite the passenger while also staying completely safe. A series of components of a roller coaster track is broken down and the movement of the cart on them was studied using calculus and vectorised forces. By using derivatives and integrals, one can analyse the design and behaviour of a coaster, from its acceleration, to the structural support the track needs.

Further to the construction of a roller coaster, it is vital to ensure safety. Factors such as the gravitational forces felt by the passengers need to be taken into account beforehand. In fact, many constructions in our everyday life follow similar principles to those of a roller coaster.

Living the thrilling moment *from the top to the drop* of a rollercoaster ride, with the adrenaline flowing through your veins has got to be one of the most breath-taking experiences that one can have. Are you ready to get thrown out of your seat in this wild mathematical ride?

MP79. IT IS A GAMBLING PROBLEM ONLY IF YOU ARE LOSING!

Stephanos Arsalides, Georgios Halios, Maria Selinopoulou, Kyriakos Tenedios.
The GC School of Careers, Nicosia, Cyprus

Many gamblers believe that they have found or will find a winning system of betting in games. Most of these proposed systems are naive, based on superstition, humorous, or sometimes pathetic. We want to shed some light on the mathematics behind some casino games and we bet you'll love it!

This project will introduce Black Jack and give a guided tour of the probabilities on how to achieve certain scores and how to improve your chance of beating the dealer. Then there is Roulette. By looking into the different bets of the game it can be proven that regardless of the amount of money bet or the combinations, the gambler is always expected to lose a consistent amount of money. As they say "the house always wins!". Through this project we will be given the opportunity to learn to spin the Slots and calculate the payback stakes of each bet, as well as how one can maximize their probability of winning. It will also be proven that the chance of winning cannot be altered.

Sometimes it is easy to put your poker face on, nonetheless we came to realise that there is a substantial amount of skill involved in understanding probability and game theory behind Poker. One aspect of the strategy of poker is to think about what cards you would need in order to win and the probability of each poker hand. So, if a mathematician walks into a casino, do you think it is worth the risk?

MP80. TOGETHER WE WILL BEAT CANCER

Nayia Aza
The GC School of Careers, Nicosia, Cyprus

Mathematıcs can save your life! From allowing doctors to calculate your heart rate for a simple check-up to assisting in beating life-threatening diseases like cancer, mathematics have revolutionized modern medicine in ways no one would expect before the first person in the world became cancer- free. Focusing on how mathematics apply to the hard journey of a cancer patient, this project is an attempt to prove how using the purest form of science, can be effective in tackling one of the most critical issues that modern society faces.

How do doctors identify cancer? An immensely significant diagnostic method is imaging, such as CT scans, whose history is merely fascinating. What do CT scans and Sudoku puzzles have in common? The idea behind Sudoku puzzles can be used to simply explain how x-ray screenings work and help in diagnosis of possible tumours. At the same time, mathematics allow for the maximum safety when undergoing such procedures, since the intensity of the rays are measured using calculus.

If results are positive, then treatment, such as radiotherapy and chemotherapy is the next step. But which method of treatment is the most effective for certain cancers? Statistical concepts can assess success rates! Demographical statistics can give us a clear image of what can trigger tumours to grow and exhibit the increase in success rates for treatment, which ultimately proves that there is hope to win the fight with cancer. Besides, there is a '*can*' in the word '*can*cer' because we *can* beat it!

MP81. THE MATHEMATICS IN BEAUTY AND ATTRACTION

Jana Gad
Rygaards International School, Denmark

Do you ever wonder, why it is that we find some people more attractive than others? Could there perhaps be a specific definition for what it is exactly that makes a person look beautiful? Research has shown that subconsciously, our perception of beauty is solely based on the golden ratio, no matter the ethnicity or race. Today, the Golden Ratio is commonly used in beauty as a guideline for aesthetic treatments and plastic surgery.

So, what exactly is the golden ratio? The golden ratio is an irrational number close to that of 1.618. Some consider it to be the most irrational number to ever exist, since it can be expanded into a `continued fraction´. It is a ratio said to have been discovered 2,500 years ago by the Greeks, however it can be found in the dimensions of the Great Pyramid of Giza which was built more than 4,600 years ago.

Even though many have claimed that attractiveness depends on personal preferences, we will be investigating if there is infact a strong positive correlation between the golden ratio and beauty. This will be done by collecting data on people's preferences on some random faces which we have chosen. For it is clear to say that the Golden Ratio has played an incredibly large role in human history and the universe and it continues to do so.

MP82. THE REAL WORLD OF IMAGINARY NUMBERS

Barouchas Harry, Stratis Kounalakis, Moschonas Gerasimos, Xenikakis Nickolaos-Rafael, Papadopoulos Nikolaos, Evgenia Skagkou
Zanneio Experimental Lyceum of Piraeus, Greece

In this work we study the most famous numbers in mathematics that draw the interest even in recent years, namely the imaginary numbers. The set of latter numbers regards the difference between the sets of numbers which can be defined by the square root of a negative number and its complement set. What is the relationship between these two sets of numbers and what kind of mathematical problems were solved through it?

We present the history behind the imaginary numbers, explain their importance regarding various fields (from science to art and philosophy), describe their relationship with the real and complex numbers and explore the strength of mathematics (fractals) and how it can be applied to many important problems arising from different scientific areas. We then proceed by giving all the necessary definitions needed to the foundation of the set of imaginary and complex numbers and the operations between them, and we also present the definition and the graph of complex function of a complex variable. We also give the Euler's identity, the most famous identity of mathematical beauty, where the imaginary numbers are protagonists in. Finally, we conclude by studying why the imaginary numbers belong to the real world, solving crucial problems in it.

MP83. REVERSING PASCAL'S TRIANGLE

Kyriacos Rouvas
The English School Nicosia, Cyprus

An easy and creative method of calculating integer powers of numbers, using Pascal's Triangle together with number walls. In a number wall, the numbers on the lower levels determine the numbers above them, which makes them in a sense reversed *Pascal's Triangles*. There are two methods of calculating powers of numbers using number walls; a universal way and a quicker way which only works with multiples of 11.

With the universal way, we first ignore the power (n) and we split our number into two '*convenient'* numbers (say x and y) that add up to our number. We then create a number wall with (n + 1) rows and put x^n in the bottom left brick and y^n in the bottom right brick. In the bricks between them, we write products of x and y with varying powers using the following pattern: Starting from the left we use descending powers for x (starting with a power that is one less than the required power) and ascending powers for y (starting from the power of 1 and ending at the power that is one less than the targeted power). To find the number at the top brick (the answer of the problem), we either compute and fill all the boxes (to find the upper brick of two bricks, you add them) or alternatively we can save time by using the appropriate numbers from a row in Pascal's Triangle and the numbers in only the bottom bricks of our number wall.

MP84. UNLIMITED CAPABILITIES: A REPORT ON VARIOUS SUBTYPES OF ARTIFICIAL INTELLIGENCE

Philippos Ganos, Antonios Panagakos, Alexios Papadopoulos, Christos Petropoulos
The American College of Greece-Pierce, Greece

The purpose of this research is to dive into certain subtypes of Artificial Intelligence. Namely, the use of AI in space exploration, paradoxes that exist in AI, while also showing how it can affect humanism in the future. Regarding space exploration, we are researching how AI can be used to collect data from planets we have visited, as well as how it will help us explore even more parts of our solar system in the future. Another subtype that is addressed is Deep Learning and Large Scale Machine Learning, which will be playing a pivotal role in every computer in the future. Lastly, we take a look at how AI is used in the video gaming industry and how, even in the most complex of games, it can outmatch any human opponent. In particular we will explore some of the most common gaming AI learning methods such as decision trees and finite machine learning.

MP85. THE WORLD'S COMMON LANGUAGE

Anastasia Nicolaou
The GC School of Careers, Nicosia, Cyprus

All languages and dialects share one thing in common, categories; they have a category for words representing nouns or objects, and a category for words representing verbs or actions. Mathematics has been around for approximately 5000 years, but still no one has been able to explain it easily. In fact, we have been mistaken all along; Mathematics is actually a language, just like English and French and not scientific terminologies as they seem.

Nowadays, in the USA only about 33% of the students are actually proficient in math. Why is the percentage so small? Is it the students' fault? Are the teachers doing something wrong? Teachers are trying to teach Mathematics in a complicated way making it hard for students to understand what they are really trying to tell. For most children, Mathematics is a general word used for 'addition', 'subtraction', 'multiplication', and 'division'. But in reality, Mathematics is way more than that. It is a way of understanding the world, it is about finding patterns explaining everything around us and viewing the same subject from different angles; having different perspectives. For example, if you take four triangles you can form a squared base pyramid without actually a base. Rotating the shape in all of the axes, you can view it from many different other perspectives.

Well… wouldn't you be interested in learning Mathematics in an easier way and use your knowledge to view the whole world differently? So, this is the right presentation to watch!

MP86. EUCLIDIAN VS NON EUCLIDIAN GEOMETRY: IS GEOMETRY ONE SIDED?

Anastasia Efraimoglou, Eleni Fouka, Evridiki Koletsou, Victoria Martin Veneti, Eirini Sigalou, Nikitas Stathopoulos
The American College of Greece-Pierce, Greece

Geometry is represented all around us in nature, in many different forms. From Euclidian to any non-Euclidian geometry, we live in a world consisted of geometric shapes that follow geometric rules. In this paper some areas of geometry are being examined, namely Euclidian Geometry, Differential Geometry, Algebraic Geometry, Hyperbolic Geometry and Elliptic Geometry. The definition, the history and the basic axioms of each area of geometry is presented and the usefulness of each geometrical system is being examined. In each case we present its origins, the axioms that govern every system and some models as well as applications and examples for some cases. It is hard if not impossible to imagine a world without geometry and that therefore proves its importance. The above is also the reason for which we chose to examine geometry in our project.

MP87. WHAT IS THE DIFFERENCE BETWEEN A CUP AND A DONUT?

Freja Johansson, Saga Anderholm Hansson
Polhemskolan, Sweden

How do you discern a donut from a coffee cup? We wouldn't know! Topology is a branch of mathematics where there, strictly speaking, is no difference between the two. Why? Both have exactly one hole each. The center of the donut and the handle of the cup. By stretching and reforming a shape it can be turned into a completely new shape, except it will still have the exact same number of holes, and therefore be considered the same in topology.

Topology is built upon some simple axioms and definitions, but very quickly, the mathematics become less general and more complex. Using the complex mathematical structures, topological spaces can be defined. These spaces later form the cup, donut or whatever shape you may desire. We are not even limited to R^3, we can go both higher and lower in dimension.

The mathematical foundation of topology is often difficult to understand. We will be explaining the basics of topology, how it works, as well as some interesting applications for it.

MP88. GENERAL-SUM GAMES AND NASH EQUILIBRIUM

Martin Boyanov Stefanov
Sofia High School of Mathematics, Bulgaria

Game theory is used mainly in economics, political science, psychology, logics, computers and biology for a big variety of situations, where the choices of the players interact between each other and influence the result. The project concerns one of the fields in applied mathematics, which studies strategic mathematical models and decision taking in situations of conflict and cooperation between rational decision-makers. Its main purpose is to present popular general-sum games and the application of Nash equilibrium.

The game theory has a long history and originally it addressed zero-sum games, in which one person's gains result in losses for the other participants. Nowadays, there are numerous types of games, which the game theory covers and in many of them we can find a secure strategy that can lead us to the desired win. However, in the general – sum games, there is no reasonable definition of an ‘optimal strategy’. That is where the Nash equilibrium comes into play - a pair of strategies, one per player, such that each is a best response to the other. Very similar to economics – you do not know which move the competition is going to make and in most cases you don’t have an ‘optimal strategy’. My contribution in the project, apart from summarizing theory and its rationale, is in demonstrating the application of Nash equilibrium through a wide variety of different problems.

MP89. ANALYSES OF LIMP ROOK, STUMBLED ROOK AND OTHER CHESS FIGURES

Ivan Ventsislavov Georgiev
Sofia High School of Mathematics, Bulgaria

This project is in the field of science "MATHEMATICS". It deals with a classical math olympiad topics, related to the possibility of covering a given connected segment (every two consecutive squares share a common side) by rook paths. Two types of rooks are considered - a stumbled rook, that moves like a standard rook but does not jump over squares and a limp rook, that moves like a stumbled rook but at every move changes the direction at 90°. Various properties of routes, paths, and cycles of those two types of rooks are investigated and summarized. The conducted analyses is based on a mixture of studying related Math Olympiad Problems from international competitions like IMO and Tournament of Towns, and creating novel math problems.

The second part of the project links the classical “eight queens problem” to the investigated rook paths. It is motivated by a purely experimental proof, which has already been available, that each of the 92 possible queen configurations on a chess board, such that no two queens attack each other gives rise to a domino tiling of the remaining part of the board. Here, I studied the possibility of covering these remaining structures by rook paths and found other important invariants regarding the queens positions on the board.

MP90. PACKING TRIANGLES IN GRAPHS WITH SUBLINEAR INDEPENDENCE NUMBER

Kaloyan Todorov Fachikov
Sofia High School of Mathematics, Bulgaria

An interesting problem in graph theory is to decompose a given graph into smaller graphs. This means to cover all edges with graphs, but without intersections of edges. A common problem is to decompose one graph into triangles K_3 and edges K_2 with cardinality π_3 as small as possible. In 1847 Kirkman showed his "Schoolgirl problem", which proves existence of Steiner triple systems in complete graphs. These systems mean that we can cover all edges with triangles. In 1966, Erdös, Goodman and Pósa proved that π_3 is at most $|G|^2/4$ for every graph G. In this project we are first looking at Erdös, Goodman and Pósa Theorem. After that we look at the particular case for complete graphs and prove that this constant approaches $|G|^2/6$. At the end we try to prove our conjecture, that if we add an additional condition, we can decrease the constant from $|G|^2/4$ to $|G|^2/6$ for every graph. Our idea is small independence number. This number shows how much vertices we can take, so that there is no edge between them. But at the end we prove that this conjecture is not true by constructing counterexample.

MP91. THE GREAT PYRAMID OF GIZA

Janat Derawi
Med High Schools, Cyprus

The Great Pyramid of Egypt is the largest and oldest pyramid of the three pyramids in the Giza pyramid complex located in El Giza, Egypt. It is also the oldest of the Seven Wonders of the Ancient World and the only one to remain largely intact. Moreover, the Great Pyramid was tallest man-made structure in the world for over 3800 years.

One of the astonishing mysteries of the Great Pyramid that are unsolved until this day is the perfection of the architecture of the pyramid. Firstly, the Great Pyramid is almost perfectly aligned with the true north (the direction along the Earth's surface towards the North Pole). The direction of the true north has changed over the years, therefore the Great Pyramid was once exactly aligned with the true north. The base of the pyramids in the Giza pyramid complex are always a perfect square. Furthermore, the Great Pyramid is positioned at the exact centre of the Earth's landmass at the points in which the longest line of longitude and latitude intersect.

In addition, the Great Pyramid encodes the dimensions of the planet Earth. The product of the height of the Great Pyramid and 43200 is the polar radius of the Earth. Also, the product of the perimeter of the base of the Great Pyramid and 43200 is the equatorial circumference of the Earth. As a result, the Great Pyramids of Egypt is a scale model of planet Earth with a 1:43200 scale.

Another evidence of the perfection of the architecture of the Great Pyramid is that the result of the division of the perimeter of the pyramid by its height is a close approximation to 2π, which is similar to a circle because the result of the division of the circumference of a circle by its radius is 2π. Likewise, the each slope of the pyramid is almost equal to 4π.

MP93. THE FIRST LEMOINE CIRCLE

Martin Lofstrom
Polhemskolan, Sweden

Although it is true that Euclidean geometry is one of the oldest mathematical disciplines and that already the ancient Greeks formalized it and had a great knowledge in it, many modern geometric theorems remained undiscovered until modern times. In the 19th century, the period in which Gauss and others expanded geometry beyond the Euclidean limits, the French geometrician and engineer Émile Lemoine (1840-1912) discovered that a triangle's symmedians, the reflections of the medians in the bisectors, are concurrent. Their intersection is now referred to as the Lemoine point or the symmedian point.

Later, he also discovered that if one draws lines parallel with the triangle's sides through the symmedian point, their intersections with the triangle will lie on a circle, which is referred to as the first Lemoine circle. As six points whose properties at first sight are not connected to a circle, normally do not lie on one, this theorem may be considered very beautiful.

In the presentation, a proof of the existence of the first Lemoine circle will be given, supposing that the symmedian point exists, with the aim to give a deeper understanding of symmedians and reflection.

MP94. Π

Ioanna Gerolemou, Tuna Erchika, Daria Shmidt
Med High Schools, Cyprus

We will do a brief explanation of what exactly π is; in basic math, π is used to find the area of a circle. We will also include an elevated description of the history behind it, we will take account of who invented it (all inventors will be written). Furthermore, we will communicate how π has diverged through dozens of years. Then, we will proceed to cover exciting topics about how π is related to the real world, such as: "How π can be used in baseball", "How NASA employs π", "In what manner you can use π in mechanics" and many more. We will correspondingly provide a slide in which we will explain exactly how π is useful and why it has so many numbers. How do we know that π has an eternally long decimal expansion? Because Lindermann proved it, using some really snappy analytic tricks. We will then write on the topic of how exactly π was discovered and why we know that it has unending decimals. We will also elaborate on how complex π is and how it can be used literally everywhere. π can be used in space, in mechanics and even in everyday life. Moreover, we will cover how famous mathematicians employed π in their own mathematical inventions. People think that π goes on indefinitely because a circle has infinite number of corners. That is a misconception about mathematics: that a number is the same thing as its decimal representation, and that curves are really polygons if you put them under a microscope.

MP95. MODELLING THE GREAT AND DIVINE COSMOS USING PRIME NUMBERS

Napolina Yiannakou, ShengKun Zhao (Barbara)
The Heritage Private School, Cyprus
Iva Betlehem, Matej Matijasic, Hana Siroki
Osnovna Skola Fran Koncelak, Croatia

In 1901, sponge divers discovered a 2,000 year-old shipwreck near the Greek island of Antikythera. Among the ship's cargo was an unimpressive green lump of corroded bronze. Rusted remnants of gear wheels could be seen on its surface though, suggesting some kind of intricate mechanism. When scientists put the mysterious bronze discovery under x-rays and through hi-tech imaging, an arrangement of bronze gear wheels was discovered confirming the idea of a complex tool. Further research revealed that the number of teeth on each wheel was a prime number or a number related to a specific astronomically important prime. Finally, studying the clockwork it was deduced that the device was an extremely intelligent calendar tracking the Moon's subtle motions through the sky, predicting the dates of lunar and solar eclipses and calculating the dates of significant events such as the Olympic Games.

Our project aims to understand the structure of this mechanism of high quality and complexity, relying on theories of astronomy and mathematics of the time.

Programming the first known analogue computer; Ancient Greeks managed to simulate the phases of celestial bodies and occurrence of cosmic events, modeling the universe with perfect precision and accuracy, in the second century BC.

MP96. HOW TO BECOME A NATIONAL CHAMPION IN CYCLING BY USING MATHEMATICS?

Natan Gregorcic
St Stanislav Institution, Slovenia

I am a Slovenian national champion in time trial, road cycling and in criterium. I would like to become a pro-tour racer and part of the Tour-de-France peloton. Regarding this, I will reveal how mathematics can help you to win different types of cycling races. In case of a time trial you ride alone. I will explain how ratios can be used to understand all the parameters that every racer should have under control. This includes the speed, defined as the ratio between the distance and time, the optimum heart rate and the cadence, defined as the number of crank rotations per minute. I will calculate also the ratio between the number of teeth of the front and the rear cogs as well as the ratio between the extent of the bike wheel and the length of the time trial. In case of the road race, the positioning within the group of other racers is very important. I will calculate the probability for the crash as a function of your position within the peloton. In my last part of the presentation, I will explain how mathematics can help you to win a criterium. In this type of cycling race, the first four racers earn points at every third lap. The winner is not the racer that finishes first, but the one that earns the highest number of possible points. Therefore, a smart strategy in earning points during sprints is of great importance.

MP97. INVITATION TO PERMUTATIONS

Krzysztof Kotarski, Szymon Nowak, Filip Zieliński, Dawid Zuk
Zespol Szkolno-Przedszkolny w Zabierzowie, Poland

The word “permutation” means to exchange or change from Latin. In other way, permutations are any displacements of elements of collection between each other by specific rules. What makes it interesting is that people use permutations in everyday life, mainly unconsciously. For example, it should be known that technology couldn’t be used without permutations. Also, Internet browsers are based on them in some part. In the times of World War II permutations changed the course of history. Polish mathematicians used them to break the enigma code- German chipper machine. We will present how to operate on permutations, and why they are interesting. We will also teach how enigma worked, and how it was decrypted.

MP98. OUR NOT SO EVERYDAY - EVERYDAY DILEMMAS

Karolina Adamczyk, Julia Janik, Zofia Kaweska, Gabriela Walczowska
Zespol Szkolno-Przedszkolny w Zabierzowie, Poland

In our presentation we will talk about different kinds of dilemmas, especially ones that normal people face most frequently. Our base is The Prisoner’s Dilemma which is when prisoners have to make a choice- to cooperate or to cheat. Their decision will reflect the length of the punishment. The choice may be influenced by the thought about the profit that one can get or their emotions. So, this is impossible to tell how people will react. We will show the mathematical way of making the ultimate best choice. Also, a questionnaire showing which option people of all ages would choose will be presented.

MP101. MATHEMATICS AND SOCIETY

Odysseas Lesko, Vaggelis Saradoulakis, Huang Cheng Yu
International School of Piraeus, Greece

Living in the 21st century, we observe that the development on many social sectors is rapid. Nevertheless, have you considered that, despite the developments, some social issues keep existing and torturing a number of people worldwide? Have you ever considered that many countries deteriorate instead of progressing due to severe social issues? We have decided to look into the sectors in which these problems are more evident, to measure, to analyse, to record statistic data and to seek the consequences on the life and evolution of the people. Where does our responsibility lay? What can we do to contribute to society’s progress?

MP102. THE MATHEMATICS ON GAMBLING

Andreas Psaltis, Andreas Michael
The English School of Nicosia, Cyprus

Everyone knows that playing casino games can be a lot of fun, not only because it is exciting, but also because the player can end up winning huge amounts of money. The very anticipation of such a win and the thrill of risking some money on a favourite game makes gambling one of the most popular and attractive activities in the recent years. However, everyone knows that the fun ceases when bankruptcy occurs. Unfortunately, a lot of contemporary casino players hardly realise how important mathematics are in gambling. There might be a small range of games which are based on randomness and pure luck, but most casino offerings are based on pure mathematics.

It is mainly probability theories that are associated with the chances of reaching a certain outcome. Therefore, understanding the mathematics that is situated behind any casino game is crucial for the player in order for him to choose the most accurate winning strategy, while annihilating his opponents.

MP103. OPTIMIZING EMERGENCY RESPONSE TIME USING MATHEMATICS AND COMPUTER SCIENCE

Andreas Lordos
The English School, Nicosia

In this presentation, we will be explaining how one can use mathematics in conjunction with Computer Science to optimize emergency response times (e.g. from a fire-station to a fire). Incidents ranging from fires, crime and car accidents occur daily, and in many cases the time it takes for emergency services to respond to the incident will vastly affect the outcome. A question arises: how can a government have a quantifiable way of knowing which communities are in most need of an emergency response center? Where should they place the new emergency response center to maximize its impact? How can we “score” the usefulness of different emergency response centers based on historical emergency data? This presentation will aim to answer all of these questions and more.

MP104. ZERO MISTERIES

Jirovieanu Nicolae Alexandru, Iordache Laurentiu Andrei
The National College Elena Cuza, Romania

Absolute zero, temperature at which a thermodynamic system has the lowest energy. It corresponds to −273.15 °C on the Celsius temperature scale and to −459.67 °F on the Fahrenheit temperature scale.The notion that there is an ultimately lowest temperature was suggested by the behaviour of gases at low pressures: it was noted that gases seem to contract indefinitely as temperature decreases. It appeared that an “ideal gas” at constant pressure would reach zero volume at what is now called the absolute zero of temperature. Any real gas actually condenses to a liquid or a solid at some temperature higher than absolute zero; therefore, the ideal gas law is only an approximation to real gas behaviour. As such, however, it is extremely useful. The concept of absolute zero as a limiting temperature has many thermodynamic consequences. For example, all molecular motion does not cease at absolute zero (molecules vibrate with what is called zero-point energy), but no energy from molecular motion (that is, heat energy) is available for transfer to other systems, and it is therefore correct to say that the energy at absolute zero is minimal.

STUDENT PRESENTATIONS IN SCIENCE

SP1. PHYSICS AND ARCHITECTURE – HOW AND WHY?

Ana Marija Habdija, Kaja Sertic
Gimnazija “Fran Galovic” Koprivnica, Croatia

As you probably know, Physics is, just like Mathematics, everywhere around us and in everything we do so Architecture is no exception. Just try to imagine how buildings and bridges, even whole modern cities, would look like if there were no physical measurements or geometry. The world would look completely different, bridges would collapse and buildings and skyscrapers wouldn’t be safe, so who knows where we would live? Maybe still in caves.

The connection between Architecture and Physics goes all the way back to ancient times. Even the pyramids in Ancient Egypt were made with a little help of Physics, otherwise they wouldn’t still be standing today. With time people started to build more complex and advanced buildings and houses. They made it all possible by getting better at both Physics and Mathematics, using more complicated formulas and calculations.

The main reason why architects need to understand some Physics is because it deals with mechanics and forces once a building is designed or built. Therefore, it wouldn’t be nice to have someone, who doesn’t know Physics very well, to project your house because you wouldn’t be sure if the house will collapse at any moment or not.

We both hope to study Architecture in the near future.

SP2. SCIENGICIAN

Andrija Njers
Gimnazija “Fran Galovic” Koprivnica, Croatia

Many unusual phenomena occur in nature around us. These phenomena can sometimes not be easily explained or understood. Sometimes they seem like magic to us. In this presentation, I will show you and try to explain this magic. I'll try to visually present some physical and chemical phenomena and their properties. I'll tell you about balance, chemical reactions, density, osmose and water properties. Everything we need to perform these experiments can be found in our households. In my presentation, I'll show you a few videos of me doing these experiments. Some will probably be shown live. For example, I'll show you how to make a cloud. Isn't that magic?

SP3. HYPOTHETICAL LIFE ON THE PLANET GLIESE 1214B

Veronica Parakhin, Sofia Baldisserotto
International School of Moscow, Russia

It was always popularly perceived that the only planet with water was Earth. Scientists believe it is this water that made life possible. People have also tried, and failed, to search for other intelligent life forms in outer space before now. That could possibly be because those planets do not have any water. But what if a planet *did* have water? What if that planet resembles Earth's early stages? That planet is Gliese 1214B, a Super-Earth planet. It is 6-7 times the size of Earth - and completely covered with water.

In this presentation, we will be creating hypothetical life forms under the water of Gliese 1214B, using the adaptations of the creatures of Earth to fit the planet's specific hot climate and high pressure.

SP4. NEUROLOGICAL DISEASES OF MANKIND AND ANIMALS: AN INSIGHT TO THE SOLUTION OF THE UNSOLVED

Seonhu Jeon, Tahee Strein
International School of Moscow, Russia

The advances in medicine have consistently allowed humanity to find creative solutions to previously unprecedented illnesses. The earliest recordings of its beginning being traced back as early as before any constructed civilisations. Since the rapid modernisation of medicine from the 19th century onward, scientific developments have become increasingly frequent, and are still making rapid improvements today to the quality of healthcare and its broadened accessibility.

However, despite such efforts, the risks in the exploration of new concepts unavoidably receive criticisms and consternation as well as providing solutions to newly discovered diseases. There is still a vast majority of chronic illnesses that apply to both humans and animals that medical practitioners cannot "cure", simply because of their complexities that cause complications in different individuals. This is the limitation of the current course of known medicine, and it provides further enquiry and research to be done in the future, as it is a continual process in efforts to surpass such impediments.

Perhaps the progressive nature in the pursuit of improved and qualified medicine to cure the sick, whether it be humans or animals, is where the heart of this presentation lies. In the exploration of common, and other rather uncommon diseases, we will investigate possible solutions for a prion disease, Bovine Spongiform Encephalopathy (BSE), with its unidentified causes, like most prion diseases. The research will be conducted based on current solutions to similar neurological diseases, on both humans and animals, to broaden the research spectrum that will lead to our conclusion.

SP5. THE EFFECT OF RADON AND RADIOACTIVITY

Lambros Lamprianou
The Senior School, Cyprus

This presentation is about the effects of radon on human health. It has been argued that radon can cause serious health damage and could be associated to the disease that has been unfortunately running rampant in recent years; lung cancer (cancer.org, 2018).

Radon is associated with mostly lung cancer (Torres-Durán et al., 2014). Scientists estimate that about 20,000 lung cancer deaths per year in USA and 16% of all lung cancer deaths in Canada are related to radon (Evans, 2015; Chen et al, 2012). Radon gas is found in soil; even rocks in our houses give out radon, which escapes through cracks in walls and floors. Radon concentrations are usually highest in the basement or small spaces and corners. So, many people are exposed to radon just by being in basements or their own homes.

Radon gas itself is not lethal, but since it *is* a gas, we breathe it in. Once it reaches in and is exposed to the conditions of our lungs, it breaks down into other deadly elements that damage the lungs and lead to lung cancer. There is almost no way to save the person affected which is why it is extremely important not to be exposed to high levels of radon for long periods of time.

Although radon levels in Cyprus are generally low (Soteriadis et al., 2016), the Ministry of Education and Culture in Cyprus should follow the good practice of other countries and investigate schools for high levels of radon.

SP6. THE REGENERATION OF NEURONS

Jirovieanu Nicolae Alexandru, Iordache Laurentiu Andrei
The National College Elena Cuza, Romania

We always believed that we stop healing neurons at a point in life, adulthood. But is that really the case? Some scientists believe it is not.

The brain is a very complex part of the body. It is been split into different sections that all do different things. For example, a part of the brain is responsible for releasing serotonin and dopamine, two substances that keep us happy, and mentally sane. These hormones come from the tegmental area. Now scientists have discovered that certain actions can aid in healing neurons, past adulthood.

Food, an important part of our life that is, unfortunately, often overlooked can have a significant impact on neurogenesis, the process of producing neurons. The kind and amount of food you eat can either be very helpful or very harming. For example, fast food is a factor in the decrease of neurogenesis, so it is much more likely to be depressed If you often eat at Fast Food chains, so you may not be lovin' it

SP7. DRIVING ON A RAINY DAY

Datis Kalali
Forum Private Greek School, Cyprus

Highway and road accidents are frequent during rainy days. In fact, in 2018 there were three consecutive accidents on the Nicosia-Limassol highway in one day, due to heavy rainfall. This project aims to calculate the maximum speed at which drivers can drive through highway curves on days with heavy rainfall and explains why a car's speed should be lower than the average speed limit on such days. Using basic laws of mechanics (circular motion), we can derive a formula for the maximum speed in terms of the gravitational constant $g=9{,}81\ ms^{-2}$, the radius of the curve and the static friction coefficient between a car's tyres and wet asphalt. During the research, the static friction coefficient was calculated through an experiment. Moreover, using basic mathematics and an image of the road from the Global Positioning System (GPS), we calculated the radius of a curve in the Nicosia-Limassol highway. Hence, using the derived formula, the safety speed limit on a rainy day is 90 km/h, which is indeed less than the speed limit of 100 km/h on the highway.

SP8. TACHYONS

Mohammad Zolfkhani
Shahid Beheshti, Iran

Albert Einistein in one of his first writings about special relativity wrote that velocities greater than that of light have no possibility of existence because of $E=mc^2$ formula.

Nowadays we know that $E=imc^2$ shows that world named tachyons world has possibility of existence. Particles of this world move faster than light because of their imaginary mass. These particles are tachyons. In my idea, our world is a world with ten different dimensions. Four of this dimensions belong to tachyons world. This worlds time dimension moves from future to past, not from past to future. Because of this causality is incorrect in tachyons world.

Tachyons energy is imaginary energy and it increases with dispatching waves. According to this we can predict the existence of a force named dark force in tachyons world. This force has a repulsion effect and it increases with r^2-$1/r^2$ formula. (r shows distance) This force can be one of basic forces in nature.

According to dark force, we can explain what is dark matter. So dark force can be a solution for us to know about dark matter. We can also explain dark energy with some properties of tachyons. Then we can predict that how will the universe will end.

Quantum information of this idea can help us to know more about, some particles such as Photons, Gravitons and Neutrinos etc.

SP9. EVOLUTION

Ksenia Dovydenko
TLC Private School Peyia, Cyprus

Evolutionary theories state that organisms evolving from the simplest to the most complex ones. Homo sapiens sapiens is the scientific name for humans. We belong to the class of mammals, who are vertebrates, warm blooded and are placental animals. The other representatives of our class are very different from each other, however, they all, for instance, apes, whales, cats, dogs, giraffes and dolphins, share the features mentioned above. Obviously, these species have not appeared the way we see them now, they have gone through a long path of deformations, genotypic mutations and phenotypic changes, climate adaptations and adaptations due to the inter actions with the other species. A comparison between humans, not the whole class of mammals and birds will be used in order to demonstrate the similarities between them. According to recent researches, human and bird brains are wired in the same way, for example, birds have a range of skills such as complex social reasoning, an ability to problem solve, some are even capable of creating and using tools. They are able to maintain constant body temperature, which is not possible in reptiles or amphibians, blood contents is also very similar to humans, for instance, blood is being oxygenated in the same way, using red blood cells, which are also red in colour due to the presence of haemoglobin, so that their blood is also red similarly to the blood in humans. The question is 'Do humans and birds have a closer evolutionary link than most people think?'

SP10. ARE TREES ESSENTIAL TO HUMAN BREATHING?

Mayya Mukhina, Polina Altchouler
International School of Moscow, Russia

Rapid deforestation is quickly leading us to a scarcity of trees. If there are no more trees left on this planet, how will humanity survive? Where will homosapiens find the oxygen required to breathe?

Many assume that without trees people will not be able to survive. However, this presentation will prove that the opposite is actually true. Oxygen is like water, there is a particular amount of it that the earth contains. Nevertheless, trees are not the only way our planet recycles oxygen. Oxygen can also be generated from algae or the ozone. Since trees release oxygen from photosynthesis as well as carbon dioxide from respiration, these two processes counteract each other somewhat.

In addition, during the winter, most trees lose their leaves. Therefore, they are unable to photosynthesise as they lack the chlorophyll needed for this action. Where does the oxygen come from if there are no leaves to photosynthesise in order to produce oxygen? This presentation will answer these questions.

SP11. SYNCHRONISING DRONES

Mayya Mukhina
International School of Moscow, Russia

Since 1920, drones have been vastly developed to such precision, allowing them to take high quality photographs and return to their starting point using GPS technology. In addition, drones now have thousands of different sensors, which enable them to be extremely stable.

Certain technological corporations have now started synchronising drones to choreograph mind-blowing shows. Nevertheless, the technology behind turning on a few different drones at the same time to lift something heavy can be very advanced

This technology has inspired this presentation, in which you will learn to construct your own drones from scratch, code them and even learn how to synchronise them.

SP12. PROPLIS AGAINST CANCER

Nadia Bakhshi
Nemone Dolati-e- Shohada, Iran

Cancer is a type of disease that is a factor in the abnormal growth of the cells of the body and the cells of the body are uncontrollably proliferating and spreading to the rest of the body.

Nowadays, with the advancement of technology, there are many chemical ways to treat cancer, but the use of natural therapies can also be effective and because they have no side effects as much as chemical drugs, they would be more efficient. For instance, green tea treats breast, stomach and skin cancer;

Another natural remedy for fighting against cancer is called Propolis. The Propolis is a substance similar to wax and it is a bee product; it also has a dense and sticky form. The smell of this material is very pleasant and its color varies from green to brown. It is a disinfectant and an effective factor in preventing the introduction and spread of diseases in the hives.

Propolis has many properties due to the presence of caffeine acid, pinocembrin, galangin, pinobaccine, cyanic acid, etc; For example: direct anti-cancer effect, increasing immunity, antioxidant effect, anti-antibacterial effect, protection against chemotherapy and radiotherapy, and so on.

Studies have shown that the use of propolis with chemotherapy is more effective than chemotherapy alone; In fact, this substance is used in advanced cancer patients undergoing chemo-therapy or radiotherapy and increases the effectiveness of treatment and reduces the adverse effects. Also, daily use of propolis in healthy people can also be very effective and strengthen the immune system.

SP13. THE SUN AS A SOURCE OF ENERGY AND THE MEASUREMENT OF THE SOLAR CONSTANT

Andreas Georgopoulos
Geitonas School, Greece

The solar radiation that reaches the earth is the fundamental cause of the existence and maintenance of life on it. In this project we will refer to the mechanism by which the huge amounts of energy emitted by the sun, the structure of the sun, and the measurement of the intensity of the solar radiation reaching the Earth are produced. To measure the intensity of solar radiation reaching the earth, we use a certain amount of ink mixed with water that is exposed to the sun for a period of time sufficient to increase its temperature to several degrees Celsius. Then using the baseline calorimetry equation we calculate the amount of power absorbed by the water which originated from the sun-emitted energy. Then we calculate the energy of solar radiation and finally the intensity of solar radiation. We compare the results of the measurements with the theoretical value of about 1kw / m^2. Through this procedure we uncover many of the factors that affect the end result and create the difference between the theoretical value and our own. Finally, we measure the influence of each factor and find ways to suppress their effect on the end result.

SP14. CARBON DIOXIDE CAN SAVE THE WATER

Bojana Marojevikj, Marija Stojcheva
Yahya Kemal College Skopje, North Macedonia

Nowadays, industrial and agricultural production, domestic consumption, as well as the number of population are increasing and that is being followed by the increased use of water resources and energy. As a consequence, a huge amount of wastewater which degrades and destroys the environment is being created. On the other side, carbon dioxide has been also increasing rapidly in the past few years worldwide. CO_2 is described as the "leading pollutant" because it contributes to climate change, which can have serious consequences for humans and their environment. Because of its harmful nature, it is a great opportunity if CO_2 can be used for something helpful that could have a good impact on the environment after all. If a person does not take appropriate measures to protect the environment, it will be overused, polluted and destroyed. After a lot of research we got inspired to think a little deeper of water and air pollution. We came to the point that it could be an amazing way to help the environment by combining two harmful things (polluted water and CO_2) in order to make two useful things (purified water and metallic carbonates which can be further used). We conducted experiments which proved that polluted water which contains heavy metals can be purified by using carbon dioxide. By using CO_2 for wastewater treatment we contribute to decrease the amount of CO_2 in the environment and protect human’s health.

SP15. MATHS IN THE TENTH DIMENSION

George Raftis
The Grammar School, Nicosia

From antiquity to today, humans have tried to explain in detail the universe, and the nature of our reality. How many times have you looked up on the night sky, perplexed, racking your mind to explain the world around you? As Mathematics and Physics have significantly advanced over the last centuries, new ideas and theories about the universe began to emerge. String theory, is a unifying theory that suggests our universe is made up of microscopic strings rather than point-like particles. As Einstein's famous equation $E = mc^2$ tells us, there is a relationship between energy and mass. Therefore, a relationship exists between an object's vibrational frequency and its mass, something that is critical to string theory. However, string theory can only work on ten dimensions. We only experience four of these dimensions in our everyday reality. Where, then are the missing dimensions predicted by string theory? In order to prove or disprove this unifying "grand" theory, a closer observation, with the use of mathematics, of each dimension is required

SP16. SPECTROPHOTOMETRY

Kakos Sotiris, Karali Alexandra, Kritharidis Konstantinos, Hadjicosta Marilena, Sfiris Haralambos Ioannis
The American College of Greece-Pierce, Greece

"But still try, for who knows what is possible"

This is a quote from one of the most influential scientists of electromagnetism in history, Michael Faraday. Based on this belief many of the most important achievements in the modern world have been accomplished. In his field specifically, the evolutions that we've seen are truly impressive and the progress increases more and more daily. An important discovery concerning electromagnetism is that these waves consist of visible light, ultraviolet, X-rays, and gamma rays. Using this knowledge, after decades of extensive research and numerous experiments, scientists created a new scientific field related to electromagnetism, spectrophotometry. Its aim is to determine what type of radiation absorbs a chemical substance. The basic principle is that each compound absorbs or transmits light over a certain range of wavelength. The spectrophotometer is the most common device used for that purpose. The first spectrophotometer, constructed by Arnold O. Beckman and his colleagues at National Technologies Laboratories in 1940, relied on using the amplifier from their pH meter, a glass prism, and a vacuum tube photocell. In this paper will be analyzed the principles of electromagnetic radiation, the history and the function of a spectrophotometer as well as the construction process of a simple version of it.

SP17. STEM CELLS

Arvanitaki Victoria, Gkerekou Georgia, Loukaki Vasiliki, Charalampos Papadopoulos-Siountris, Christina Servou, Antonia Stamatellou
The American College of Greece-Pierce, Greece

The stem cells are of utmost importance for all organisms to survive and most cells in our body come from them. They have the ability to reproduce and to differentiate to any kind of cells in the body thus replacing damaged or diseased cells. Stems cells can be found in any human body. More specifically, sources of stems cells are the placenta and the umbilical cord blood, the umbilical cord tissue, the primary dentition and the adipose tissue. Stem cells can be used for the cure of malignant diseases, especially in one's blood or for problems in the metabolism. Furthermore, it is possible to use them to restore the function of organs and bones that might not be working correctly either from accidents or aging. Also, many transplants in bone marrow have been done successfully. Other than the usual uses of stem cells they appear to be able to help in complex and various ways patients, research studies and even companies, corporations or governments. For example, advance treatments for cancer and genetic defects and even test new drugs for safety and effectiveness. It is vital for human stem cells to be preserved for future treatments and clinical trials. Today, this is achieved with two methods namely, cryopreservation and hematopoietic preservation. Using a specific web platform, we will study ways of differentiation in stem cells. Moreover, we will attempt to examine different parameters of transforming one type of stem cell to another. Ethical aspects of stem cells applications will be examined.

SP18. CAN IT BOUNCE

Owen Pritchard
TLC Private School Peyia, Cyprus

We have all been there, you drop an egg on the floor and it cracks, making a mess. But have you ever wondered, what if an egg could bounce? Well what if I told you, it can. In my presentation I will discover and explain the process and the science behind how an egg is able to bounce. First of all, eggs break because force is concentrated in one area of the eggshell, the egg shell isn't strong enough. When the egg hits the floor it is stopped by the force of hitting it. If you drop an egg on the floor its speed changes from about 3m/s to stopped in a very short period of time. So how does it end up bouncing?

SP19. CHROMATOGRAPHY

Giagli Xenia, Maravitsas Konstantinos, Papadakis Nikolaos, Papakosta-Sampatakaki Kanella, Papanikolaou Archonto-Rafaela
The American College of Greece-Pierce, Greece

Chromatography has provided significant contributions to the fields of molecule characterization as well as purification processes over the last century, thereby being quite unique in its flexibility and scalability. The history of chromatography begins during the mid-19th century when a rudimentary version of the technique was used for the separation of plant pigments such as chlorophyll. Column chromatography was popularized during the 1930s when the chemists Richard Kuhn and Edgar Lederer successfully used the technique to separate a number of biologically important materials. Chromatography is a process by which substances can be separated from their mixtures. There are many types for each of which different materials are used but they work in the same way. The mixture to be analyzed is placed on one end of the material, called the "stationary phase" and is carried to the other end of the material by a fluid, called the "mobile phase". As some substances are more soluble in the fluid, they travel at faster speed, and thus their separation is achieved. Modern chromatography is applied in many fields of science, such as Biology, Medicine, Pharmacy, Technology, Chemistry, Agriculture, Toxicology, as well as in food science and industry. Chromatography, therefore, contributes to the development of the sciences all over the world and to the invention of many beneficial for humanity techniques. In this article, we will analyse the history, the basic principles, current applications and different categories of modern chromatography, in addition to an experimental part of paper chromatography.

SP20. PHYSICS OF THE BRAIN

Deniz Akansoy, Leonie Kallis, Omer Emir Serak
The English School of Nicosia, Cyprus

The objective of this presentation is to investigate the link between the scientific areas of physics and biology; more specifically, how existing knowledge, as well as new research based on physics, has been used, and still has the potential to help further our understanding of the human brain, both in everyday life, as well as in the developing branch of cognitive science.

The first part of the presentation addresses a topic which every human being is subjected to throughout their lives, sound waves, and how they affect the brain. Questions such as how the brain relates various sounds to certain emotions, as why different combinations of frequencies create different effect on one's psychology, are explored in relation to evolutionary psychology. The physics aspect behind the nature of sound, how different waves lead to different sounds being heard, as well as how these sound waves are interpreted by the nervous system are discussed.

The second part, is regarding how sound waves, followed by physics in general, can be (and currently is being) utilised in medical fields, as well as leading to new discoveries. Relatively new and very topical concepts, such as MRI guided focused ultrasound used to destroy tissue, as well as the future possibility of using high-frequency waves to perform non-invasive brain surgery are explained. Finally, the future of sonogenetics, which until now has shown success in roundworms, including the possibility of human application is explored.

SP21. FLY A DRONE, SAVE A FOREST

Nikolas Hadjipaschalis
International School of Paphos, Cyprus

All around the globe we are facing one of the most menacing threats – climate change. Using unmanned aerial vehicles equipped with cutting edge technology, it is proposed that it is a cheaper, safer, and more time-efficient alternative in fighting climate change. These agile devices are able to record critical data that could be useful in predicting changing climate patterns. Drones are superior to humans in collecting data since they can take readings more frequently, can access remote locations that may be expensive or dangerous to get to and can take more accurate readings. By studying surface reflectivity of rainforests, scientists are now able to more accurately determine where new seeds need to be deployed to counteract deforestation, and in doing so reduce the risk of invasive woody plants such as lianas growing. Lianas are detrimental since they strangle large trees and block them from receiving enough sunlight. The result? These trees die off releasing tonnes of CO2 into the atmosphere – a greenhouse gas. Due to extensive research in recent years, and especially thanks to the help of drone technology becoming more commercially available, ecologists have found that liana populations have more than doubled. So could drones be the ultimate technical tool to tackle climate change?

SP22. BALLET

Laetitia Mukiza, Maria Yiasoumi
Med High Schools, Cyprus

We are going to explain how ballerinas are able to stand on their tip toes, pirouette endlessly and more. We'll explain how ballet shoes are most suitable for their kind of movement and even exemplify a famous ballet dance like the Nutcracker.

We're mainly talking about its physics but we'll also mention either some equations or other relations to mathematics.

The 'hardest move' considered in ballet is the fouette (non-stop pirouette). The friction between the ballerina's toe and the ground and somewhat between her body and the air actually reduces her momentum. As she rotates on and on, she will either lose speed or balance that is why there is a little trick. In the split second when the ballerina has faced her starting position once again, her steady foot will flatten to the ground and push off into a twist, maintaining her balance and speed pushing against the floor to generate a tiny amount of new torc. Meanwhile, her arms sweep open every time her foot flattens to keep her balance – most effective when her centre of gravity remains stable keeping her spinning posture vertical. Both the arms and foot help her fouette but the real secret, the way you barely notice her short pause is because her other leg never stops moving. During her momentary pause, her elevated leg keeps passing non-stop. As she straightens her elevated leg when it passes her balancing leg and bends as the fouette proceeds. By staying in motion, that leg is gathering the momentum of the turn. When she brings it back closer to her body, the momentum travels back to the dancer's body, making her rotate easier as she gets back on her point. As she extends and retracts her leg with each turn, the momentum travels back and forth, between her leg and body, keeping in motion.

The longer her leg is extended, the more momentum it stores, and the more momentum that can return to the body when she retracts it again. The more momentum she has the more turns she can make.

More explanations can be included in ballet and it is interesting to find out the physics behind it all.

SP23. CYCLING

Anna Kalaitsidou
Med High Schools, Cyprus

In a breakaway group, the power required to overcome air resistance is reduced because the lead can be shared. Demand-side simulations show that the critical factors are: the distance remaining in the race; the speed of the breakaway group; the number of riders in the chasing and breakaway groups: how closely riders in each group draft one another; the grade; surface roughness; as well as head- and cross-winds. When supply-side physiological factors are incorporated, the maximum sustainable speed and maximum lead time can be calculated.

Overall Formula:

x means "multiplied by". ^2 means squared, i.e., (V+Vwind) x (V+Vwind) = (V+Vwind) ^2. The C's in the formula below are various constant amounts, which vary according to the input units used

Wrider = Cfriction x V x P + Cair x (V + Wind)^2 x V+ Slope x P x Slope% x V + acceleration[Using the above equation, if we know the total power put out by a rider) the coefficient of friction of the bicycle) the weight of the rider the component of the Wind speed acting against the rider, and the percentage of slop (and if we assume that the rider is not constantly braking and accelerating up to speed) we can calculate the speed that will be attained by the rider, and therefore the distance he will cover in an elapse of time.

- Basic formula distance = speed x time

SP24. SPEED

Marco Marcou
Med High Schools, Cyprus

Many people {parents} think that speed is only how fast their cars moves. NO, that is one of the fewest belongings you can measure in speed. There are a lot more possessions:

- The speed of light {299 792 458 m / s}
- The speed of sound{343 m / s}
- How fast our body reacts to an object {the speed of the brain}
- The speed of gravity {<299 792 458 m / s}

Speed can be thought of as the rate at which an object covers distance. A fast-moving object has a high speed and covers a relatively large distance in a given amount of time, while a slow-moving object covers a relatively small amount of distance in the same amount of time.

SP25. THE PERFECT HIGH-FIVE

Zeno Kafetzis, Elizaveta Porunova, Alexander Kalaitsides, Andrea Efstathiou, Raphaella Gregoriou, Diba Salamat
Med High Schools, Cyprus

The project will be based on how to make an accurate, perfect high-five. When person **A** and person **B** are in position to give a high-five, they must be standing upright and at the time of movement person **A** must look at the elbow of person **B** and person **B** must do the same by looking at person **A's** elbow. The elbow must be those of which will be on the same arm that the high-five will take place. Once both people are looking at each other's elbows, they must swing down, while still focusing on the opposite elbow, and their hand will meet to make a perfect high-five. We will experiment the effect of this theory on a short person compared to a tall person and see of the results are still accurate. We will explain the angles of the swinging arms to show how the experiment will be effective. Finally, we will see how the velocity will affect the force exerted on the hands, we will also see how the time will affect the high-five.

SP26. WHY DO WE DREAM

Omar Hmaydani
Med High Schools, Cyprus

Theories:

- We dream to fulfil our wishes
- We dream to remember
- We dream to forget
- We dream to rehearse
- We dream to heal
- We dream to solve problems
- We dream to fulfil our wishes

Collections of images from our conscious life's and also have symbolic meaning which relates to the fulfilment of our subconscious wishes. Freud theorizes that in terrifying dreams everything that we remember from waking up from a dream is a representation of unconscious desires.

We dream to remember

Dreaming on something makes you better at them. In 2010 a study when the subjects went through a maze and took a nap the ones who dreamed about the maze did much better than the ones that just took a nap.

We dream to forget

While sleeping in the REM stage your neocortex's drops unnecessary information, creating dreams.

We dream to rehearse

We rehearse threatening scenarios so we know what to do in real life, this can go from instinct reactions to reproductive reactions.

We dream to heal

While dreaming our brain brakes down traumatizing experiences so we can live them with less mental stress making them less traumatizing and to allow psychological healing,

We dream to solve problems

Dreams = unlimited scenarios which can help you grasp problems, and formulate solutions that you may not have considered while awake.

SP27. QUANTUM MECHANICS: EVERYTHING AND EVERYWHERE

Maria Tivanova
The Heritage Private School, Cyprus

In its nature, a challenging and interesting area; quantum mechanics is the branch of modern physics that explains the nature and behavior of matter and energy at subatomic levels. The presentation will be focusing on how quantum mechanics interconnects with all aspects of life. This includes everyday activities, theories, studies and even an explanation of how the universe works. The study of this specific branch of physics includes all aspects of our, and perhaps interstellar, lives and consists of theories that explain all other theories…or at least most of them.

SP28. HYPNOSIS

Eleftherios Nikou, Isabella Cairns, Lydia Wells, Mathew Kuzmin
TLC Private School Peyia, Cyprus

Have you ever wondered how hypnosis works on a scientific level? Hypnosis is the induction of a state of consciousness in which a person apparently loses the power of voluntary action and is highly responsive to suggestion or direction, as it is defined by the internet. How could this link to science? Our aim is to unveil the hidden science behind hypnosis. Believe it or not, the average person experiences hypnosis at least twice a day. A common example is binge watching your favourite TV programme and barely realise that half a day has gone by. Hypnosis was first discovered by Franz Mesmer in the 1700s. His surname Mesmer led to the invention of the word mesmerize which is commonly used. Hypnosis is commonly used to cure stress, anxiety or pain for up to 300 years but people still don't know the science behind it. We hope to enlighten people about hypnosis and its benefits but also its risks. Negative reactions to hypnosis are rare but some that may occur include dizziness, headaches, drowsiness or creation of false memories.

SP29. THE MIRAGE TO REALITY

Andrea Alexandrou, Sophia Constantinou, Vasiliki Kalimera, Michalis Kasoulides
The English School Nicosia, Cyprus

The human brain can be easily fooled by optical and sonic illusions. Even though these illusions can be extremely mind-boggling and sometimes even frustrating to understand, they can be explained using simple, applied laws of physics. The way that light can be perceived is truly fascinating. Still images give the impression that they are moving and thus convey a sense of magic. Furthermore, depending on a sound wave's frequency, people can hear the same sound wave coming from the same source in a different way. For example: Have you ever wondered how the two words 'Laurel' and 'Yanny' that sound so different from each other can be interchanged? What about the phenomenon of an object being able to disappear when placed in a particular liquid? The explanation for these phenomena can be found in physics and the different perceptions that each individual develops, as each one of us has his or her way of thinking and understanding things differently. Well, it is time we start to contemplate once in a while how things operate. Only then, will our life become more fascinating and exciting.

SP30. TIME TRAVELLING

Vrettas Christos, Bompitsis Kostantinos, Vretta Theodora
Diastaseis Private School, Greece

Have you ever heard the expression “never say never”? Well… in this occasion I don’t think it is going to be helpful. I presume you all know either heard the book or the film time machine (there were two movies actually the original, 1960, and the remake, 2002). The movie evolves around a professor who after the murder of his fiancée decides to invent a time machine in order to prevent her death. The idea, the motive and the attempt of man to travel in time can be characterized with one word… romantic. As far as I am concerned there is no scientific theory that can fully support time travel and to be honest even if there was a possibility of time traveling I don’t think anyone should possess this kind of power.

However, something that it is possible according to Einstein’s theory of relativity is to slow down time. How can something like that happen? Something like that can happen only if we travel very fast in addition with someone who is stationary. Of course, in order to slow down time significantly we will have to travel with speeds similar or higher to the speed of light (300,000 km/s or 186,000 miles/s). Unfortunately, until we manage to travel faster than the speed of light we will have to leave these kinds of scenarios to science fiction.

Finally I need to notice that when we say that it is possible to slow down time we mean that we slow down time relative to someone else. Both the traveler and the person who can be assumed stationary according to traveler don’t notice anything different. The time for both of them is passing as usual.

SP31. CYPRUS HERITAGE EXPLORING WITH QUANTUM PROGRAMMING

Aleksander Bosek
XIV LO im. St. Staszica, Poland

We describe each world heritage sites in Cyprus, interactively choose desired ones and compute several optimal tourists' routes for visiting from following:

- Paphos, Choirokoitia, Painted Churches in the Troodos region, Kimia, Khandria, Troodos (Mt. Olympus) and Malounta Bridge.

Quantum simulation code is applied to a Travelling salesman problem (TSP).

Our aim is to plan the trip through Cyprus heritage sites with making as little kilometers as possible. We apply TSP approach, where vertices of the graph are identified with places and edges between vertices are given weights equal to the distance between corresponding places.

Traveling Salesman Problem is a problem consisting of finding Hamiltonian cycle with minimum weight in an edge-weighted complete graph.

We utilize quantum programming to solve that NP problem. Quantum TSP algorithm is more efficient than classical discrete one.

We illuminate the powerfulness of quantum computing, which development and introducing into everyday life is highly likely to be the tipping point in human progress.

Quantum computers offer us promising computing power with eco-friendly resources and they can be applied in tourism industries for both trip calculation and marketing purposes.

SP33. SOLVING THE GLOBAL ISSUE OF OIL SPILLS

Valmir Iseini, Damjan Konjanovski
Yahya Kemal College Skopje, North Macedonia

Oil spills are one of the greatest issues that the modern world is facing right now.

Not only it has affected the coral life but nature in general. We as humans cannot give up oil but what we can do is try to minimize the negative effects it has on our planet. The main purpose of our project is to tackle this issue by increasing the efficiency of the cleaning process. We used a 40 liter bowl of water containing 1 liter of oil in which we placed two electric mini boats that were connected to each other with a boom that we previously added magnets to. Subsequently, we used the mineral magnetite, which poses no threat to the nature and mixes with oil without attracting water. We added the mineral on the surface of the bowl, where the oil was highly concentrated. We started the mini boats, making a 180 degree turn around the bowl with both of the boats. This means that the oil and magnetite mixture was trapped between the sides of the boom, and was later on attracted to the magnets on the boom. In conclusion, our project serves as an idea for reducing the negative effects of the oil spills. If employed in real life, it can drastically impact the process of cleaning up the oil from the water and serve as an alternative and more efficient ecologically friendly way of solving this problem.

SP34. WORMHOLES

Bogdan Fomichev
International School of Paphos, Cyprus

What are wormholes? Wormhole is a speculative structure linking disparate points in spacetime, and is based on a solution of Einstein field equation. It is visualised as a tunnel through spacetime with two ends in different points of space and with a very narrow way in the middle of it. Wormholes are related with the theory of general relativety, but we don't are they real or not. Wormholes have a very large difference between its' working distance. It can connect as a very large distances such as billions light years, galaxies, different points in time but they also can connect very short distances such as few meters.

The solution for wormholes was found by Schwarzschild, but unfortuenately Schwarzschild's wormhole would collapse in its' middle while nothing could go through it.

There is also a possibility of having a wormhole with two enterance and two ends. This is only possible if exotic matter with negative energy density could be used to stabilize them.

If for example wormholes do exist, it is very hard to find them and it is also very hard to distinguish them from black hole. The only way to do it is to go through it. If an object doesn't have event horizon then we will have a wormhole. If we will be able to find of those then it will be defined that travelling through space and time is possible.

SP35. HAZELNUT SHELL BRIQUETTES

Eda Avmedovska, Eva Lazarevska
Yahya Kemal College Skopje, North Macedonia

One of the greatest eco-issues in the modern world is deforestation. The aim of our project is to tackle this eco-problem by employing hazelnut shells to provide an alternative heating solution. A total amount of 7 kilograms of hazelnut shells was put through a chain of machines in the "Max Energy Bio Pellet" factory in Serbia. Here they were transformed into eco-friendly briquettes. We conducted several experiments to test the quality of our briquettes in the college laboratory in the Faculty of Design and Technology of Furniture and Interior, part of Ss. Cyril and Methodius University, Skopje, with the help of Prof. PhD Gjorgji Gruevski. We tested the a) Calorific Value –it was 22956 kJ/kg, notably higher than the standard for wood briquettes, measuring a minimum of 16750 kJ/kg. b) Ash Content –it was calculated to be 0.2%, strikingly low. c) Sulphur Content –we determined it to be 2%. d) Percentage Moisture Content – the briquettes contain 3.01% moisture, compared to the standard maximum 18% of wood briquettes. Based on the gathered data, we concluded that the hazelnut shell briquettes are more efficient and of higher quality than the standard wood briquette. They are completely safe and natural and pose no threat to the environment. Implementing their usage would reduce air pollution and deforestation in two aspects, the first one being that less trees are cut down for the purpose of heating, and the second one being that this would encourage and stimulate the growing of hazelnut trees.

SP36. HEAVY METAL REMOVAL WITH VINEGAR: APPLE, GREEN GRAPES, BLACK GRAPES, POMEGRANATE

Tea Smilevska, Dea Rajhl
Yahya Kemal College Skopje, North Macedonia

Necessary substance to stay alive is water, especially clean and fresh water. Without water, there would be no vegetation on land, no oxygen for animals to breathe and the planet would look entirely different than it does today. This gift of nature makes up 70% of the surface of the Earth with only 1% of that as fresh water that is easily accessible and not trapped in glaciers and snow fields. This natural resource every day becomes less and less accessible, and its availability is big economic and social problem. This study was conducted to investigate the effect of aqueous solution formed from Apples, green grapes, black grapes and pomegranate (They were waited 45 days to become organic vinegars.) water mixture(organic vinegars) and its ability of heavy metal absorption.

Heavy metals that we used were: **Zinc ($ZnSO_4.7H_2O$), Copper ($CuSO_4$), Lead ($Pb(NO_3)_2$), Manganese (MnO_2)** from multi-component systems at different adsorbent/metal ion ratios. We used these heavy metals altogether since we tried achieving the same level of pollution like the ones in the most polluted waters flowing in Macedonia. The optimum absorption was found to occur at contact time 18h, adsorbent dose from highest range from 99.1% for Pb (10% black grapes vinegar) to lowest range to 10.10% for Zn (5% solution green grapes).

Different parameters such as amounts and absorption of heavy metals were evaluated. Our aim is to prove that with this natural resources we can make the quality of water way better, especially the quality of polluted water, and with that we can make better conditions for living and we will make better environment and make our lives better. Our earth is getting more polluted every day, we live in environment where we breathe toxic gasses, not oxygen. As environment is getting polluted also water is getting more and more polluted every day. Some people like those in Africa don't have water even to drink, and we are polluting our water with heavy metals.

For our project we chose the organic vinegars (apple, green grape, black grape and pomegranate) because this vinegars are: easily accessible to everyone, low- cost and not harmful to nature.

SP37. PLASTIC OF POTATOES

Valmir Iseini, Damjan Konjanovski
Yahya Kemal College Skopje, North Macedonia

Plastic is one of the most commonly used materials in the world. *"Bio plastic" is a non-harmful plastic,* derived from biological substances, with the main aim of replacing conventional plastics since they take thousands of years to decompose, they are a major contributor to pollution, and problematic to sea life. There are different types of bioplastics, such as Starch, Cellulose, Protein-based bioplastics. With our project, we introduce a potato starch based plastic. To make plastic out of potatoes, we used 100g clean potatoes, Grater, Glass rod, Distilled water, Pestle, mortar and a 100 cm^3 measuring cylinder. We started by grating 100g of potatoes, then we put them into the mortar and added 100cm^3 distilled water. We grinded the potato carefully, poured the liquid off through the tea strainer into the beaker, leaving the potato behind in the mortar. We poured the water into the other beaker, making sure we did not pour the starch too. Subsequently, we added more destilled water in the 500ml beaker, we stired it and waited 20 minutes for the solid-liquid separation to occur. After washing the starch, we dryed it in an oven at 250C, for 10 minutes. The dried starch was pure crystalline solid. The project in our chemistry laboratory happened in three phases: Plastic from potato starch with glycerolum, without glycerolum and with glyceroum and gelatin.In conclusion, plastic from potatoes is eco-friendly, renewable, does not contain toxins and uses 65% less energy for production.

SP38. AERODYNAMICS IN OUR LIVES

Kaloyan Todorov Fachikov, Martin Boyanov Stefanov, Ivan Ventsislavov Georgiev
Sofia High School of Mathematics, Bulgaria

What is aerodynamics? That is an exciting field in physics, which studies the motion of the air, particularly as interaction with a solid object. We cannot see this interaction as clearly as we can see the interaction between water and a solid object, for example. However, that does not mean it is unimportant. Aerodynamics consists of a lot of components – downforce, lift, air flow and so on, but maybe the most important is drag coefficient. It is about how an object is affected by the fluid environment around it, like air or water and is measured by the velocity, the drag force, which is the force component in the direction of the flow velocity, the density of the fluid and the reference area. The properties of aerodynamics are used everywhere – in car and plane manufacture, for example. Moreover, every building has its own drag coefficient and unique aerodynamics. In our project, we are going to show you all formulas connected with that, explain to you how aerodynamics work in our lives, why are there properties so important and also how a small addition to an object can change its aerodynamic properties dramatically.

SP39. GOAL IMPOSSIBLE

Yiannis Ioannou, Anastasis Nicolaou, Chris Leonidou, Stylianos Fatouros
The GC School of Careers, Nicosia, Cyprus

Are you a football lover? Do you admire great goals perfectly executed? Have you ever seen a goal and wondered whether it is even possible? Well, we will be presenting one of the most outrageous goals ever scored in football history.

The impossible goal was scored in the Copa Del Ray final in 2015 and it stunned everybody watching at the moment! It is not only the goal itself that amazed everybody but the overall movement, the agility needed, the technique on the control, the instant acceleration to maximum speed in just a few seconds. Apart from all that it was scored from a very difficult angle and the skills used when the ball was kicked to the back of the net were such that no goalkeeper in the world had a chance of saving it.

Passion, determination, thirst for success, trophies and fans that offer amazing atmosphere. This is what makes us love football so much and we will be presenting a great goal of this beautiful game at its peak.

We will be trying to recreate the goal with people from the audience in an attempt to examine whether it is possible or not.

SP40. BEFORE THE ALARM GOES OFF

Tereza Michael
The GC School of Careers, Nicosia, Cyprus

Wake up! Wake up! You've slept enough!! How many times have you slept more than 9 hours? Sleep is an essential part of our daily routine, as we spend around 33% of our time sleeping. Quality sleep and obtaining enough of it is as fundamental to survival as food and water. Without sleep you cannot form and maintain the pathways in your brain that let you learn and create new memories, and it is harder to concentrate and react rapidly.

Until the 1950s, we thought sleep was an inactive action. Nowadays, we know that our brain is extremely active and neurons in our brain are on fire even when we are sleeping. With the help of science, we accomplished to calculate the amount of sleep needed through the five stages of sleep. These stages progress cyclically from 1 through 5 and afterward start again with stage 1. A total sleep cycle takes an average of 90 to 110 minutes.

While we sleep our minds create stories and images called dreams. They can be entertaining, fun, sentimental, distressing, terrifying, and weird. Dreams however are a continuing source of mystery for scientists and mental specialists.

Wouldn't you like to learn what happens while sleeping? Wouldn't you like to learn how to calculate your bedtime? Wouldn't you like to learn how we dream? Well, let's find out how much science there is behind our sleep.

SP41. OPTIMISING OF WASTE COOKING OIL INTO BIODIESEL

Dren Kaliqi, Mervesena Cengiz
Yahya Kemal College Skopje, North Macedonia

Worldwide petroleum-based energy resources are being depleted – onshore crude oil production peaked decades ago but our demands for petroleum are still going up. Biodiesel is one of the two liquid biofuels that in the short term is expected to contribute the most to reducing current EU-25 50% external dependence on fuels for transport. The United States' continued dependency on imported petroleum, particularly from the Middle East, has become an important national security issue. Lastly, environmental concerns such as pollution and global climate changes provide further motivation to address the energy challenge that we face today. Technology is available, biodiesel texture is very similar to oil-derived diesel, and economic profitability seems sufficient thanks to the existent framework of fiscal and other financial supports. In the present work, we focused on the production of biodiesel (which is an important biofuel) from vegetable oils. With the conventional technology, vegetable oil mixed with alcohol (e.g., methanol) reacts in large-scale batch reactors and in the presence of an alkaline liquid catalyst (e.g., NaOH or KOH) to form methyl esters or biodiesel and glycerol or glycerine. The transesterification reaction can take up to 12 hours or longer to complete; and at the end of the reaction, it is necessary to use an acid to neutralize the liquid catalyst and to separate biodiesel and glycerol from the product mixture, and use it.

SP42. HERBS AND MEDICINE

Irene Kokiasmenou, Eleni Papadopoulou, Alkmini Mantzouratou, Anastasia Saltou, Eleftheria Koutsouraki, Stellina Monastiridou
International School of Piraeus, Greece

What do you know about alternative medicine? Which illnesses does it heal? Where does it come from? Nowadays, alternative treatments have appeared addressing a variety of ailments and many natural products and herbs can currently be found in pharmacies. However, since ancient times certain peoples have been turning to nature seeking treatment ergo they found medical methods which were primarily based on the use of herbs. As years went by, people evolved thus the science of medicine has begun to rely on the use of chemical substances and modern machines for both the prevention and the remedy of diseases. In a time of evolution, how can "old methods" be incorporated? Should we return to tradition or put our faith in evolution? Let's try to answer this through a comparative study. However, the overuse of these products has been scientifically proven that negatively affects brain function. In this study, the consequences on the human brain of overexposure to radiation will be shown as well as on different age groups and potential safety measures. Is it possible that we will have to change out habits in order to be healthier? How easy it that?

SP43. ELECTRIC DEVICES AND HUMAN BODY

Jin Hao, Philippos Panourgias
International School of Piraeus, Greece

In modern societies electric devices are necessary and present in people's everyday lives. Mobile phones and portable devices' market have increased during recent years since more and more people use them to cover multiple needs (communication, online briefing, use of GPS, music, games, social media, photographs etc.). However, the overuse of these products has been scientifically proven that negatively affects brain function. In this study, the consequences on the human brain of overexposure to radiation will be shown as well as on different age groups and potential safety measures. Is it possible that we will have to change out habits in order to be healthier? How easy it that?

SP44. THE EFFECT OF AN ORGANIC SURYP WITH ARONIA AGAINST THE DUST MITE ALLERGIES

Jana Majnova
Yahya Kemal College Skopje, North Macedonia

While living in the 21st century we are facing some real problems that have a negative effect on human health. Unfortunately, the air in our city is much polluted, being on the list of the top 3 most air-polluted cities in the world. This causes many people's allergies and illnesses. However, I will stick to one of the worst allergies, which is the dust mite allergy, that, unlike the other ones it is present in all the seasons through the whole year. Unluckily, I am one of the millions of sufferers from this allergy. Or we can still say luckily because I proposed a new natural way of treating it.

From the researches made about the plant *aronia*, I came to an idea to use it for making organic syrup on a completely natural basis. This syrup is consisting of: aronia berries, lemon juice, sugar and water. I used it instead of drugs against my allergy, assuming that it will treat not only the symptoms, but the immune system, as well. So, I made blood tests to compare the results after using the prescribed medications by a doctor and after consuming *the syrup.* It turned out that the better results with lower immunoglobulin levels were shown after using this miraculous syrup. This idea is innovative and different from the other ideas, because unlike the other treatments for allergies, that contain corticosteroids and other harmful active substances, this is completely natural and it does not have any side effects.

SP45. DOG-A MAN'S BEST FRIEND

Nikoletta Antoniou, Elicia Byans, Zara Dolman, Annie Lin, Aimee Mcgawn
TLC Private School Peyia, Cyprus

44.8 million people in the USA alone have dogs as pets and there's a very good reason for this. Dogs are used for several tasks and jobs; police dogs, therapy, guard dogs, herding, etc. Most dogs are just loveable companions (a recent study has shown that people who have dogs actually live longer!) These dogs enrich the lives of their families by providing companionship and unconditional love. Studies have shown that pets can provide health benefits in reduced stress. Because of this benefit, some pet dogs become therapy dogs and visit patients in hospitals and residents in nursing home. Dog noses aren't just a little more advanced than human noses, they're about 100,000 times more advanced! Dogs have about 25 times more smell receptors than people do, and a 40-times-larger olfactory cortex to boot. Your dog smells in parts per trillion. What does that mean? If we were to dilute an ounce of blood into 20 Olympic-sized pools, your dog would be able to smell that drop of blood. Amazing, right? So, it makes sense that with their intense sniffing abilities, they'd be led by scents. That's why dogs use scent to help them download certain information about people and other canines. Using scent to understand who they're dealing is simply just a dog thing and it's because they're driven by their snouts. The questions to be answered are why do dogs seem to like some people more than others and why have we chosen them as our friends?

WORKSHOPS

WS1. ELEMENTARY PARTICLE PHYSICS AT CERN

Professor Evangelos Gazis
National Technical University of Athens, CERN

CERN is the European Organization for Particle Research, a world Center of. Excellency in basic research and science. Physicists and engineers are probing the fundamental structure of the matter aiming to the origin of the universe the called Big Bang (BB). They use the world's largest and most complex scientific infrastructure consisting of accelerators and detectors. The charged particles are accelerated in opposite directions colliding, finally, together at speed close to the velocity of light. The Higgs boson was discovered at CERN by these accelerators, which provides mechanism for the mass origin of the nature.

WS2. MEDICAL APPLICATIONS BY NUCLEAR & ELEMENTARY PARTICLE PHYSICS

Professor Evangelos Gazis
National Technical University of Athens, CERN

There is a unique innovative technology developed at CERN for the needs of the research goals. This technology has many applications in industry, materials, electronics, computing, informatics, agriculture, commerce and MEDICINE. The scientific achievements coming from the medical applications targeting the diagnosis (use of radio-isotopes) and therapy of the cancer (use of radiation of photons and particles) will be presented.

WS3. FUNECOLE® DEVELOPING THE WHOLE CHILD

Chryso Christodoulou, Digipro Education Limited, Cyprus

This practical workshop combines two areas: teaching coding while infusing key social-emotional learning skills. Digital learning tools help reinforce social-emotional concepts through six-year-long sequences using real-world themes as anchors, developing global, civic and environmental awareness. CASEL encourages “social-emotional learning” embedded in other curricular areas; here it’s coding, digital citizenship and tech tools, including Apple, Windows or Chromebooks. The workshop reveals how animated characters and STEAM activities can scaffold crucial SEL concepts in an age-appropriate manner and focus on student-centered issues and questions. Tech tools are taught and help students present findings and reflections. ISTE Aligned, Endorsed by Cambridge International Certifications for Cambridge ICT Starters Initial and Next Steps qualifications, Best Practice for Creative Learning and Innovative Teaching by European Commission.

WS4. ESCAPE ROOM

Marina Furkes, Bojana Habek
Gimnazija “Fran Galovic” Koprivnica, Croatia

Students will be presented with an interactive game called Escape Room. Teachers decide how much time students have to complete the tasks. (In this case the game will last 40 minutes.) The tasks will of course contain math problems. For this game every group of students needs to have one smartphone with an internet connection and a QR code reader application. Every clue they solve leads them to another link with a new problem. The first group that solves all the clues is the winner. The tasks will be prepared for primary school students but also applicable to secondary school students. Although the game can be played outside the classroom, our game will be held inside the classroom. This activity is great for team building activities, and for students just getting to know each other! We hope both the students and the teachers will have lots of fun.

geometric bodies, straight lines, mass, angles, plants, insects, water cycles, chemistry of atom, molecules, bonds, refraction, interference, planets, earth

WS5. METAMORPHOSIS OF MATHEMATICAL ASSIGNMENTS

Mara Grasic, Osnovna Skola “Braca Radic”, Croatia
Ksenija Varovic, Osnovna Skola Fran Koncelak Drnje, Croatia

In mathematics class, assignments have a prominent role. We can split them into two categories: standard and non-standard assignments. Standard assignments include assignments that sharpen specific skills or teach a specific formula. On the other hand, non-standard assignments include problem-solving tasks. So why wouldn’t we transform those standard assignments into something more interesting to students.

The goal of this workshop is to demonstrate that every assignment can be made more interesting.

The students will be split into five different groups. Every group will be given unfinished tasks. They will try to finish the task and compose additional questions that will make the tasks more interesting. Students’ creativity will be of major importance. In the end, every group will present their work. Through talk and analysis, we will see the students’ role in composing the tasks which will positively affect the students’ motivation.

WS6. DIVISIBILITY OF NUMBERS

Sava Grozdev
VUZF University, Bulgaria

Various problems are discussed for the divisibility of numbers and some criteria are deduced. The workshop is suitable for 6-9 grade students.

WS7. PRIME NUMBERS

Sava Grozdev
VUZF University, Bulgaria

Several problems are proposed leading to different hypotheses for prime numbers. Recent scientific results are considered in the domain. The workshop will be suitable for 9-11 grade students.

WS8. ROMBOTICS FOR MATHEMATICS STUDENTS

Pericles Cheng
Cyprus Computer Society & ROBOTEXT CYPRUS

In this workshop the use of robotics in mathematics education will be explored. Participants will be able to learn how to program robots to perform various tasks linked to mathematics such as distance based on wheel circumference, triangular motion, speed and acceleration.

WS9. ROMBOTICS FOR MATHEMATICS TEACHERS

Pericles Cheng
Cyprus Computer Society & ROBOTEXT CYPRUS

In this workshop the use of robotics in mathematics education will be explored. Participants will be able to learn how to program robots to perform various tasks linked to mathematics such as distance based on wheel circumference, triangular motion, speed and acceleration.

WS10. THE MATH-GAMES METHODOLOGY: HOW TO LEARN THE BASICS OF MATHEMATICS BY PLAYING GAMES?

Roland Schneidt
Volkshochschule Schrobenhausen, Germany

The European Erasmus+ Project 2015 to 2018 "Math-GAMES - Games and Mathematics in Education – Compendiums, Guidelines and Courses for Numeracy Learning Methods Based on Games" will help to answer the questions:

- How can we reduce the number of people, who cannot count and calculate, to promote social integration and participation into our society?
- How can we increase incentives in education by using games?
- How can we offer tailored learning opportunities to individual learners by using games?

During the workshop Math-GAMES the Co-ordinator of the project Roland Schneidt will explain the project and the material, which can be downloaded for free from the website and which will help the teacher to use a methodology based on games www.math-games.eu
In addition, an example is discussed of how to use a selected game in the classroom to learn basics in Mathematics. The workshop is aimed primarily at teachers who want to get to know the MathGAMES methodology. However, interested students may also participate.
As the MathGAMES project has now been finalized, the workshop participants' experiences and opinions are interested to see.

WS11. ON LINE ARRANGEMENTS AND THEIR PROPERTIES

Baeta Deregowska
Pedagogical University of Cracow, Poland

It is a very classical subject of mathematics to study arrangements of lines and their properties. In this workshop I will make an introduction to combinatorial methods in geometry. There will be plenty of examples illustrating the general ideas and patterns. The participation does not require any prior knowledge. A set of color pencils might be helpful.

WS12. CHEMISTRY OF CLIMATE

Claire Polycarpou
International School of Paphos, Cyprus

To accept Climate change students have to understand the implication of the anthropogenic changes onto our ecosystems. Recent focus has been on plastics but the effect of carbon dioxide and acid rain on the oceans and aqueous systems are underestimated. This workshop will look at the amount of acid rain, acid concentration and the speed at which this affects shell fish, coral and other species through a combination of calculations and experimentation.
It can be further used to explain buffers and how gas emissions should be a concern to us all.

WS13. ‘MAGIC FREQUENCIES’ OR ‘SEEING SOUND’

Despina Demetriou, Andrea Hadjialexandrou
International School of Paphos, Cyprus

“There is nothing in the world that doesn’t talk to us.
Everything and everyone reveals their very nature,
character and secrets continuously.
The more we deploy our inner senses,
the better we understand the voice of all things.”
Hazrat Inayat Khan (“Music and Mysticism”)

Everything that exists vibrates, every atom, every cell, stone, plant, each being. In essence we are frequency, vibration that miraculously manifests itself as matter, body, sound or color.

This workshop is aimed towards children 10-15 years old. It employs the use of modern technology and digital media in order to create a better comprehension of the ways vibrations are responsible for the sounds we hear and how visual patterns of audio frequencies can be seen through vibrating materials e.g. sand, water. During the workshop we will attempt to demonstrate these effects, causing fascinating patterns to emerge.

Students will have the opportunity to learn about the properties of sound and how it travels through different mediums using visual methods.

WS14. MAKE YOUR OWN PH INDICATOR AT HOME!

Natasa Savva, Viviana Petinou
International School of Paphos, Cyprus

This hands-on workshop is designed to teach students about acids and bases by looking at the pH of household products using red cabbage indicator. Red cabbage juice contains a natural pH indicator that changes colours according to the acidity of the solution. Red cabbage contains a pigment molecule called flavin (an anthocyanin). This water-soluble pigment is also found in apple skin, plums, poppies, cornflowers, and grapes. Very acidic solutions will turn anthocyanin a red colour, neutral solutions result in a purplish colour and basic solutions appear in greenish-yellow. Therefore, it is possible to determine the pH of a solution based on the colour it turns the anthocyanin pigments in red cabbage juice. The colour of the juice changes in response to changes in its hydrogen ion concentration. Red cabbage juice indicators are easy to make, exhibit a wide range of colours, and can be used to make your own pH paper strips.

WS15. SHOEBOX HABITAT

Antonis Ignatiou
International School of Paphos, Cyprus

Children have active imagination. They always make creative new connections, which aids in a child's natural ability to come up with stories. Storytelling does not only help in English lesson but it is an important science skill as well. In this activity children use their storytelling skills to explore different animal habitats. This is a great activity to get children learning about geography, environments and animals. This shoebox diorama activity will expand their knowledge in habitats making a connection between knowledge and storytelling behind their creation. A habitat is an area with specific climate and ecosystem, where plants and animals get what they need to survive. Deserts, rainforests, grasslands, ocean, shoreline and wetlands are the main habitats found around the world. Each habitat has its own landscape and wildlife. To build the shoebox habitat you can use different materials for each one. Stickers, small plastic animals are used to portray the wildlife in the area. First, start by choosing an animal to learn about. Study the animal and fill an information sheet. Secondly, create a shoe box diorama for the animal using construction paper, paint, clay, natural materials, drawings, printed pictures and other household material to create the animal's habitat. There is possibility for differentiation according to the year groups that are doing the project. This project can be applied from year 2 students up to year 6.

WS16. MIND MAPPING FOR CHEMISTRY CONCEPTS

Natasa Savva, Viviana Petinou
International School of Paphos, Cyprus

Mind mapping is an extremely powerful technique in memorising and learning in a creative and visual thinking manner. In conjunction with brainstorming it is an innovative tool to keep students engaged and interested, unleashing their creativity and become more independent learners. The left side of the brain is responsible for tasks that have to do with logic, analysis and sequencing, it is better at things like reading, writing, and computations. On the other hand, the right hemisphere coordinates tasks that have to do with creativity and arts. The right brain is more creative, visual and intuitive, working on imagination, rhythm and colours. If both brain hemispheres are used in learning, memorising becomes more effective. The idea is that it is an advantage to activate as many areas of the brain as possible by the combination of holistic perspectives using the right brain section and complementing it with details and structures using the left part of the brain. Mind mapping is claimed to get students to learn more meaningfully. They are able to use their acquired knowledge and concepts through images, shapes and colours, allowing them to correct mistakes and make necessary amends easily. Focusing on effective learning through mind maps in chemistry, students reach knowledge making it permanent. It can be said that this practice is significant from the point of teachers and students who study chemistry.

WS17. 'BIOLOGICAL MOLECULES' AS LEVEL

Sotiris Antoniades,
International School of Paphos, Cyprus

The teacher develops ideas for students to build large models of Molecules (which is part of their Biology curriculum) using recyclable materials such as plastic bottles and soda cans. The molecules become part of the teacher's lesson, which motivates the students as they become involved in creating the models, adopting a positive approach to the study of molecules. All models are suspended and displayed in the classroom. Recyclable materials are used as they are inexpensive and easy to collect. Other materials used in the construction of these molecules included acrylic paints, spray paints, glues, silicon adhesives, wire,string and wall hooks. The teacher prepares a theme and a design for a different model each year. The project is assigned to the team, discussed and then it is developed by the group to completion. Models of Biological molecules are constructed from litter, such as plastic bottles, and become part of the teacher's lesson in the classroom. Students become creative, working as a team, encouraging each other in these fun projects.Each member of the team is required to perform a task, before the whole molecule can be assembled. Each task is manageable enough for an individual or a team to complete. The teacher guides the students with intervention at any point, as required. A project can take up to 3-4 months to complete, either in lessons or as a club. By constructing this model, the students are encouraged to develop inquiry and team-building skills at each stage of the project.

WS18. EXPERIMENTAL AND HANDS-ON ACTIVITIES BY ENGINO® USING THE PRODUINO™ CONTROLLER

George Keliris, Xenia Giannakou
Engino, Cyprus

The controller is specially designed for students aged 14 and over, and is an ideal solution for a robotics hobbyist. The controller is equipped with an LCD display, 6 buttons and 7 ports that connect to various sensors such as touch, infrared, ultrasonic, colour, magnetometer as well as DC and Servo motors!

The controller is programmed using a user-friendly Scratch-like software, with coloured and distinctive action blocks. The embedded platform of Arduino allows enhanced capabilities and DIY electronics, while introduces users to C ++ programming language. The system is a complete set, providing all the necessary tools for developing educational activities through robotics!

WS19. THE HIDDEN SECRETS WITHIN THE TERMS OF A POLYNOMIAL

Andreas Demetriou
The Heritage Private School, Cyprus
Cyprus Mathematical Society

Polynomial functions are among the simplest, most important, and most commonly used mathematical functions. These functions consist of one or more terms of variables with whole number exponents. All such functions in one variable (usually x) can be written in this type of format:

$$f(x) = a_n x^n + a_{n-1} x^{n-1} + \cdots + a_1 x + a_0,$$

In fact, polynomial functions are not too dissimilar to our whole number system. We count with and use a base 10 (decimal) system. Polynomials such as the function above are a "base x" system.

In the workshop we will mainly focused on the roots of the polynomials and the hidden information within each term by referring to the Fundamental theorem of Algebra, rational root theorem, Vieta formula, Descarte's Rule of Signs and Newton's Sums.

WS20. THE MAGIC OF SCIENCE

Dimitropoylos Manolis, Kopaila Hliana, Gerovasiliou Antonia
Diastaseis Prívate School, Greece

Why does it rain? Why the sky is blue? Where does the light come from? How many times had the teachers to confront the curiosity of students? And how frustrating the answers to all these amazing questions must have been?

The magic of science is an attempt to show students the fun side of physics and chemistry. Our workshop concentrates in generating the curiosity of students and pass them through the theoretical terms of science to the experimental world. Theory and experiment combine their power in order to lead us to the magic world of science.

The philosophy of our workshop is to build interesting and intriguing experiments, with easy to find materials even in our own home. The students find themselves in a classroom where an egg, a lemon and a glass of water explain a variety of laws of science. They build their own experiments changing the factors and observing the outcome.

The students and teachers during the strict curriculum tend to sacrifice their imagination and fantasy in order to keep up with the program. Our propose is to let students experience the true face of science and express their natural curiosity and fantasy.

WS21. ENJOYING MATH

Anita Grguric, Zlatka Miculinic Mance
Prva Rijecka Hrvatska Gimnazija, Croatia

The purpose of our workshop is to show how we popularize mathematics in our school. Thinking how to make math more liked, we came to idea to organize math competition together with our partner school in the city. The competition was held already three times and it is becoming a regular and popular part of two schools cooperation. Several teachers, including two of us, are preparing tasks for students of age 15 and 16. Students are formed in groups of four and have some 30 minutes to solve math tasks. We would like to organise a competition at this event in the similar way as we are organizing it in our schools thus showing our colleagues teachers how to make math more fun and accepted by new generation of students.

WS22. MATHEMATICAL GAMES

Tomasz Szember
Pedagogical University of Cracow, Poland

I will present two elementary games (triangles, dots and lines) and discuss interesting mathematical background. The workshop can be attended by students from age 12 on and by teachers.

WS23. PLAYING WITH FAIR AND BIASED COINS

Karol Gryszka
Pedagogical University of Cracow, Poland

This workshop is intended for teachers and students with no limitation on age. I will present a simple mathematical description of fair and biased coins (the intuitive approach based on probability). The main goal of the workshop is to explain how (un)important bias is and how can we make one coin fair (biased) if a given coin is biased (fair).

The second part of the workshop is devoted to generalizing previously learned ideas in the case of draws with more than two outcomes, for instance dice rolls. In fact, the nature of coin flips allows to, in some sense, generate any reasonable distribution, that is to assign any probability to any number of outcomes. I will provide some algorithms whose efficiency will then be subject to testing.

CING BIOINFORMATICS SYMPOSIUM

CS1. BIOLOGY IN NUMBERS

Andrea Kakouri, Maria Zanti
Bioinformatics ERA Chair, The Cyprus Institute of Neurology & Genetics, Cyprus

The human body is made up of 37.2 trillion cells. Your nose can remember 50,000 different scents. Sneezes regularly exceed 160 km per hour and nerve impulses to and from the brain travel as fast as 322 km per hour. Fascinating huh? Who would imagine that maths and biology are not unrelated at all?! The human body is the most complex machine ever created. It carries out about 37 thousand billion billion chemical reactions per second! It works based on 11 different organ systems, composed by more than 78 organs, and more than 200 different types of cells. It is no wonder why billions of euros are spent each year on the research of human biology and diseases. Consider, that variation in our genome, makes us being 99.9% genetically similar, but how come we feel so different from that person we run into on the street? On the other hand, isn't it great that no one is exactly the same with any other people on earth? Come and meet biology with mathematical accuracy to understand how our body works!

CS2. MEDICINE IN NUMBERS

Christiana Christodoulou, Kyriaki Savva
Bioinformatics ERA Chair, The Cyprus Institute of Neurology & Genetics, Cyprus

The human body is an amazing machine, from the eye, which is, roughly 576 megapixels in camera terms. We also have our every own supercomputer, the brain which is able to process and store information faster than any computer. The signals from the brain that travel along the nerves at 322 km/h that is faster than the cheetah! Sometimes the body may need some help from medicine and doctors. Medicine is helpful since it is used in the diagnosis, treatment and prevention of disease, which can help save a patient's life! Nowadays, this can be done through personalised medicine based on the person's genes and condition of each individual. From writing prescriptions and drug dosages, imaging tools such as MRI and CAT scans, to designing mathematical models for a particular disease, maths are more than necessary! Moreover, even surgeons use maths to calculate how much anaesthetic needs to be given to the patient! If you haven't ever thought how important maths are in the discipline of medicine, come and we will be here to talk to you about it!

CS3. MATHEMATICAL MODELING OF THE BRAIN

Margarita Zachariou
Bioinformatics ERA Chair, The Cyprus Institute of Neurology & Genetics, Cyprus

What do we know and don't know about the brain? Are our thoughts, decisions and actions determined by neuronal activity? Can mathematical models help us understand the brain? Can we study how neural activity changes in disorders of the human nervous system using mathematics?

The brain is one of the largest and most complex organs in the human body. The activity of the brain emerges from networks of neurons and molecules interacting in a dynamic way. We will discuss how mathematical models and computer simulations are used as a powerful strategy for understanding the complexity of the brain and studying disorders of the human nervous system mathematical models and computer simulations can be used.

CS4. BIG DATA OMICS ANALYTICS

Anastasis Oulas
Bioinformatics ERA Chair, The Cyprus Institute of Neurology & Genetics, Cyprus

Technological advances in the field of "omics" and the advent of next generation sequencing (NGS) are a landmark in the current era of research and innovation. These technologies provide a spectrum of information ranging from genomics, transcriptomics and proteomics to epigenomics, pharmacogenomics, metagenomics and metabolomics.

Bioinformatics and computational biology have made significant breakthroughs towards the analysis and interpretation of the data obtained from big data omics technologies. The sheer size of data generated by these high-throughput methodologies coupled with the need to analyse, integrate and concurrently interpret this avalanche of information in a systematic way, has had a direct impact in the evolution of Bioinformatics and other related fields.

CS5. COMPUTATIONAL INTELLIGENCE IN BIOMEDICINE

George Minadakis
Bioinformatics ERA Chair, The Cyprus Institute of Neurology & Genetics, Cyprus

Computational Intelligence (CI) is an offshoot of Artificial Intelligence (AI), concentrated in the study of adaptive mechanisms and computational systems, able to address and solve complex problems of the real world. Using nature-inspired computational approaches, CI facilitates intelligent behaviour in complex and changing environments that leads to the development of innovated clinical and computer-based decision support systems. To this extend, the purpose of this course is to address basic principles of various powerful CI methodologies that are currently utilized for biomedicine and bioinformatics-oriented applications. Through this course, students will be able to conceptually understand the philosophy and mathematical concepts of machine learning algorithms, as well as to cross-fertilise their existing knowledge in mathematics with innovative decision making technology in the field of biomedicine. The course is divided in two major parts. Basic Principles of Computational intelligence: This is a brief review on the theory and concepts behind Artificial Intelligence and its applications, highlighting techniques and best practices used in machine learning computational environments. Computational Intelligence in Biomedicine & Bioinformatics: includes a collection of examples, methodologies and applications used in the fields of biomedicine and bioinformatics.

CS6. GRAPH THEORY BEHIND BIOMEDICAL NETWORKS

George Spyrou
Bioinformatics ERA Chair, The Cyprus Institute of Neurology & Genetics, Cyprus

Biological data have tremendously expanded both in size and complexity. Systems Bioinformatics focuses on the investigation of such vast and complex biological systems and their within interactions using a ‘holistic’ rather than a ‘reductionist’ approach, much like the systems biology field. A holistic approach to science and the analysis and description of a complex phenomenon emphasizes the whole and the interaction of its parts, whereas the reductionist approach focuses on the fundamental parts. Casting biological systems as networks and analysing their topology can be useful in understanding how such systems are organized. Graph theory provides a powerful mathematical framework for the understanding of the organization of such large and complex systems by considering them in the form of graphs. Graphs, also termed as networks, can be used to model the pairwise relations between objects. A network is a collection of nodes or vertices connected by edges, arcs or lines. It may be undirected, meaning that there is no distinction between the two nodes associated with each edge, or its edges may be directed from one node to another. In cell biology, nodes represent cellular components (e.g. proteins) and edges represent interactions or other relationships between these components [e.g. protein–protein interactions (PPIs)]. Basic network measures can be used to analyse the components of a network, both locally and globally, and facilitate the analysis and extraction of useful information from a biological network. These concepts with related examples are going to be presented in this session of the workshop.

ASTUCON PRESENTATIONS

AP1. DEVELOPING DYNAMIC CAPABILITIES IN PUBLIC SECTOR ORGANIZATIONS

Tharwat Jaber
Frederick University, Cyprus

In 21st century the world has been facing increasing challenges based on the effects of globalization (economic, social, political, and technological changes), all of these have had strong impact on the organizational performance.

In response to those global challenges, the concept of smart and innovative development is one of the most striking subjects in management literature, with the majority of studies focusing on the relationship between innovation and its ultimate consequences of sustained economy.

In this lens, public sector organizations (PSOs) are facing difficulties in adapting to the rapid changes in the environment and responding to the demands of different stakeholders.

Given these new and difficult circumstances, PSOs are requested to adopt smart, innovative development policies through building dynamic entrepreneurial capabilities, deploying resources efficiently and developing employees' competencies.

To achieve all this, public organizations can act entrepreneurially by creating bundles of capabilities, which may lead to entrepreneurial initiatives and actions, these capabilities are increasingly seen as a critical success factor for PSOs.

Therefore my research will try to answer the question of how PSOs change in response to their increasingly turbulent and complex environments, and how they establish, maintain, reshape, and dissolve their capabilities.

AP3. WAYS OF MANAGING GOVERNMENTAL BUREAUCRACY: AN EMPIRICAL PERSPECTIVE

Timotheos Dimitriou
Neapolis University Pafos, Cyprus

The negative impact of bureaucracy is gradually spreading in the Public Sector of Cyprus and tends to become a permanent nightmare for its citizens. The Department of Lands and Surveys is a strong and representative example of today's prevailing situation, as it consists of more than ten departments and sectors. The cases are sent back and forth between the departments and offices without actually being forwarded on to the next stage so that their completion date can be accurately calculated. The citizens justifiably complain that they may have to wait for up to 5-10 years to get a certificate of final termination of their case.

The present study - presentation deals with the plan of implementation as well as with the methods that nowadays have been processed by the department managers, and concern the organization of human and material resources. The focus is mainly on human resource management and on the allocation of cases based on the relative difficulty of their implementation. Equally significant is also the empirical capacity of the writer himself, as part of the operating system of the Survey sector on part of the employee. People expect to be informed and wish to the effective management of their cases, something that constitutes a bet both, for each one of them individually as well as for all employees together.

AP4. LEARNING STYLES QUESTIONNAIRE PRIOR AND AFTER IMPLEMENTATION OF HYBRID PBL

Kyriacou Andria-Anna, Nicolaou Stella A.
University of Nicosia, Cyprus

Problem-based learning (PBL) is a student-centric approach to teaching. During PBL, an interesting problem is posed to students and through brainstorming sessions, answers are hypothesized and learning objectives are identified for independent study. The aim of this research was to identify any changes to students learning styles through the implementation of hybrid PBL in the MSc level and whether PBL is a significant medium to guide their educational experience. Students enrolled in the MSc Biomedical Science-Immunology course for the fall semester 2018 participated in this study. The fall curriculum included four classes, Cellular and molecular immunology and Bio-analytical and diagnostics technologies taught in a hybrid problem-based format and Molecular genetics and Pathophysiology of disease taught in a lecture format. The learning styles were evaluated using the Honey Mumford questionnaire, designed to identify students preferred learning styles, enabling the student to identify the best learning experience suited to them. The questionnaire was administered in the beginning and at the end of the semester. Results from comparisons between the two questionnaires revealed that students after PBL shifted their preferred learning styles into a mixture of learning styles, ensuring that the implementation of PBL provides a more holistic approach to learning.

AP5. EXPECTATIONS AND RESULTS OF COMPANIES IN PRACTICAL BUSINESS PROJECT

Inri Sumitra Dewi
Saxion University of Applied Science, Netherlands

Universities and businesses work more and more together. “Triple helix model” and “open innovation” models have played a role in the development of more practical forms of business education, such as the development of mixed international student teams that would work on solving questions related to further internationalization of businesses.

This paper focuses on the expectations of Small and Medium Sized businesses that cooperate with universities for expanding their knowledge on issues like for example international market research/expansion, outsourcing and/or international supply chain. The paper consists of an analysis of in-depth interviews with SMEs from different countries that participated in such projects. The results show that most of the companies indicate that their expectations are partially met, and several suggestions are given to increase expectations management towards the companies involved, so that the effectiveness of future projects can be increased. For both universities this information is very relevant to improve the quality of their practical business education, as well as for companies in order to get a better understanding of what is realistic to expect from such types of cooperation.

AP6. UNIVERSITY OF LIBRARY STUDIES AND INFORMATION TECHNOLOGIES – SOFIA, BULGARIA

Eva Tsenkova, Simona Dusheva
State University of Library and Information Technologies, Bulgaria

The rapid pace of development in education and science has put new challenges on the one hand to various educational, scientific and cultural institutions, and on the other has led to difficulties related to the preservation and preservation of collective human memory. The organization of scientific research and the implementation of various methods for safeguarding the tangible and intangible cultural heritage have avoided a number of problems in terms of its preservation and socialisation. A good example in this direction is the international Southeast Summer University (ISSU), which is organized by the University of Library studies and Information Technologies (Unibit) – Sofia, Bulgaria. It allows young people to participate in field research by combining modern learning approaches with traditional. ISSU promotes the continuity of knowledge and experience between young people and professionals from different fields of human activity, enabling them to participate actively in all studies and research in a real working environment. Enables young people to form active citizenship, make important decisions, and last but not least contributes to the diffusion of knowledge and experience, which, combined with the ambition of young people, creates preconditions for new scientific achievements.

AP7. CROWDFUNDING AS A NEW FUNDING SOURCE: ITS POTENTIAL AND FACTORS DETERMINING SUCCESS

Anna D, Anyfantaki
Frederick University, Cyprus

Crowdfunding is a newly introduced source of funding and thus, deeper investigation is essential and the concept involves funding an idea from a small number of donors. Its component parts are the crowd, the creator of the idea and the online platform. This study aims to investigate the factors that ultimately determine the positive influence, leading to a successful funding of a project. This is achieved by collecting data from the best-known Crowdfunding platform, namely Kickstarter, and by running multiple statistical analysis models. Data from the 100 most successful and 100 failed projects were collected. The main results were that almost all projects had an introductory video embedded onto their main profile and the money invested per backer was of the same size class amongst both groups. Higher chances of success can be seen in the category of Technology and Games, whilst the chance of success drops noticeably in the category of Arts. The higher the financial goal and the number of updates, the higher the chances of a successful project, while the opposite holds true for the duration of funding.

AP8. ANALYSIS AND RECONSTRUCTION OF REAL CAR ACCIDENTS WITH THE AID OF PC-CRASH SOFTWARE

Matthew K. Alpas
Frederick University, Cyprus

Road traffic accidents are the largest cause of death injuries worldwide. Only in Europe, car crashes claimed 26100 lives and 1.4 million injured people. This creates critical questions, regarding the need of reconstruction and analysis of car accidents, so as to understand and if possible, prevent their causes. The aim of this study is to contribute and shed some light to the mechanisms, forces, and momentums that are being developed, as well as to the behavior of drivers and their vehicles, by simulating real-world accidents in the PC-Crash program. Through many different trials, it was confirmed that overlapping width, contact plane angle motion direction, initial velocities and point of impact and deceleration have the biggest influence to the behavior of the cars in collisions. The main outcome was that with the use of this software and the right input data useful information can be provided about post-collision motion and pre-collision speed and the program can emerge as a powerful tool to be used from specialists and car industries.

AP9. RENDERING SOUR INTO SWEET NATURAL GAS

Panayiota Argyrou, Constantinos Hadjistassou
University of Nicosia, Cyprus

Amine units are considered as the most appropriate systems for treating sour natural gas. Their large space and weight footprint, high running costs, initial capital investment and design complexity offer room for improvement. We have looked-into the current amine design methodologies which rest on the solvent circulation rate as a way of determining the absorber and stripped dimensions, the pump duties and heat exchanger surface area. Closer inspection of these analytical relationship reveal that the amine circulation rate does not factor in important parameters such as pressure, temperature, reaction kinetics, inlet liquid flow rate and others. We have analytically modelled the amine process. Aspen Plus was used to simulate certain elements of the amine process in the context of the equilibrium and a rate-based approach. Preliminary results reveal that the circulation rate of amine depends linearly on concentration of amine which is in good agreement with the theory. It is noticed that there is a non-linear dependency on the inlet sour gas stream which requires further investigation. The circulation rate showed an exponential relationship with temperature and pressure of both inlet streams which satisfies the consideration of reaction kinetics rates during simulations.

AP10. UN-ILLUMINABLE ROOMS AND THEIR APPLICATIONS

Panagiotis Antoniou
European University Cyprus

The illumination problem is well--known in the area of optics and dynamical billiards: Is a mirrored polygonal region illuminable form every (resp. at least one) point in the region? The former problem poses a restrictive condition, and as such, was solved for polygonal rooms by Tokarsky.

We will focus on the latter problem: the study of regions that are not totally illuminable after a countable number of reflections. The Tokarsky 26-sided un-illuminable room is the primary example of such a region. It has the property of always having at least one un-illuminated point - regardless of the original placement of a light source - which can radiate in all our directions. An improved version of the latter, a 24-sided polygon, was put forward by Castro. Lelievre et al. extended this in the following form: a light source in a polygonal room whose angles (in degrees) are all rational numbers will illuminate the entire polygon, with the possible exception of a finite number of points.

The un-illuminable room problem finds many applications spanning several fields of Physics (including Optics, Wave and Field Theory) which are vital to Satellite Surveillance, Radar and Sonar placements; Biology Echolocation, etc.

AP11. DESIGN AND CONSTRUCTION OF A TENSION LEG PLATFORM FOR WAVE AND WIND EXPLOITATION

M. P. Charalambous, T. P. Mazarakos
University of West Attica, Greece

In this paper, experimental investigation on the wave run up of a floating wind turbine (WT) of 5 MW subjected to waves are presented and discussed. The experiments were conducted using a scale model (1:100) of a floating structure with three cylinders spread symmetrically, constructing an equilateral triangle with the wind turbine at the center of the triangle, in the laboratory wave basin, at the Department of Naval Architecture, University of West Attica, Greece. The model is fabricated using PVC tubes. The turbine blades were also fabricated in PVC, in which the profiles of the blades are as per the National Renewable Energy Laboratory (NREL) 5 MW wind turbine. The influence of the turbine blade rotation on the wave run up of the structure was investigated and the responses of the system under regular waves were presented in terms of statistical values. The experimental results obtained from numerical investigation gives the wave run up near the structure. The mooring system used in this study is a Tension Leg Platform (TLP) system.

ASTUCON WORKSHOPS

AWS1. TECHNOLOGICAL ACHIEVEMENTS FOR THE FUTURE ACCELERATORS AT CERN

Professor Evangelos Gazis
National Technical University of Athens, CERN

The best and innovative technology developed at CERN is related with the prototype machines called accelerators of the charged particles. The accelerators of type linear or circular are providing the charged particles, mainly electrons or protons in extreme values of velocity approaching the speed of light. The secrets of the electromagnetic theory implemented for the accelerators operation plus the various kinds of modern accelerators will be presented.

AWS2. CERN LAB

Professor Evangelos Gazis
National Technical University of Athens, CERN

There will be presented, with on-line applications of various codes, the theory of the elementary particle physics and the various particles properties during their transmission in the matter, the called detectors. The students will get a glimpse of the software tools used by the researchers for their elementary particle investigation.

AWS3. HEALTH AND SAFETY, LUXURY OR A NECESSITY

Nikos Anastasiou
Leptos group, Cyprus

This Workshop examines the effectiveness of the Occupational Safety and Health Administration (OSHA) on reducing occupational injuries, fatalities and increasing effectiveness. This Workshop examines factors that may contribute to the success or failure of the agency to meet its mandate. Agency, economic, and workforce factors were considered to see how they influence occupational safety.

This workshop uses literature and data on BLS, NIOSH, OSHA, OLS, national and local Health and Safety organizations.

This Workshop will review all legal frameworks worldwide, in European Union and Cyprus and indicate the importance of Health and Safety at work. The case study as well undertook an interview as a primary method of obtaining information on Health and safety practices on a local business.

The findings indicate that the company has indeed, placed Health and safety measures in place but there is need to make improvements. Based on the conclusion, the study recommends that training of employees on health and safety needs to the main focus for local business and those will be presented on the workshop.